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Founded by J. A. Nieuwland, C.S.C.

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N. B.—Increased production costs forced The American Midland Naturalist to assume a quarterly status as indicated on the cover of the last issue (Vol. 50 (1):1-256). Previously the journal was published bimonthly and one member of the Monograph Series was published annually. The latter series which was discontinued in 1952 has been revived on a self-supporting basis based on sales of previous volumes. Unfortunately, the subscription price of the "Midland" cannot be reduced because of high costs of production—The Editor.

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John D. Mizelle, Editor

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Birds of the Nueltin Lake Expedition, Keewatin, 1947

Francis Harper

The John Bartram Association, Philadelphia, Pa.

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INTRODUCTION

The vast stretch of country lying between Hudson Bay on the east, the lower Thelon River on the north, Athabaska and Great Slave Lakes on the west, and Reindeer Lake on the south, has been for generations a challenge to explorer-naturalists. Few areas on the mainland of western Canada have constituted such an extensive biological *terra incognita*. This block of approximately 150,000 square miles has remained a virtual blank space on distributional maps of plant and animal species. In times past the chief deterrent to exploration was the difficulty of access to this lonely land, inhabited only by a few bands of Eskimos and Indians, with here and there a white trapper or trader. Numerous rapids and portages, together with stormy weather, made canoe travel slow, difficult, and dangerous. Air transportation, now become commonplace in the north, has revolutionized the situation.

For some 30 years I had cherished the idea of utilizing Nueltin Lake, a hundred-mile-long body of water lying across the Keewatin-Manitoba boundary, as a base for biological exploration. In 1947 I was finally enabled to carry out this plan. It was supported chiefly by the Arctic Institute of North America with funds supplied by the Office of Naval Research, while an auxiliary fund was contributed by the Reading Public Museum and Art Gallery, Reading, Pennsylvania.

Although Nueltin Lake was still represented merely by broken lines on the latest official maps in 1947, it had actually appeared on a map as long ago as 1795, when Samuel Hearne published his classic of Arctic and Subarctic

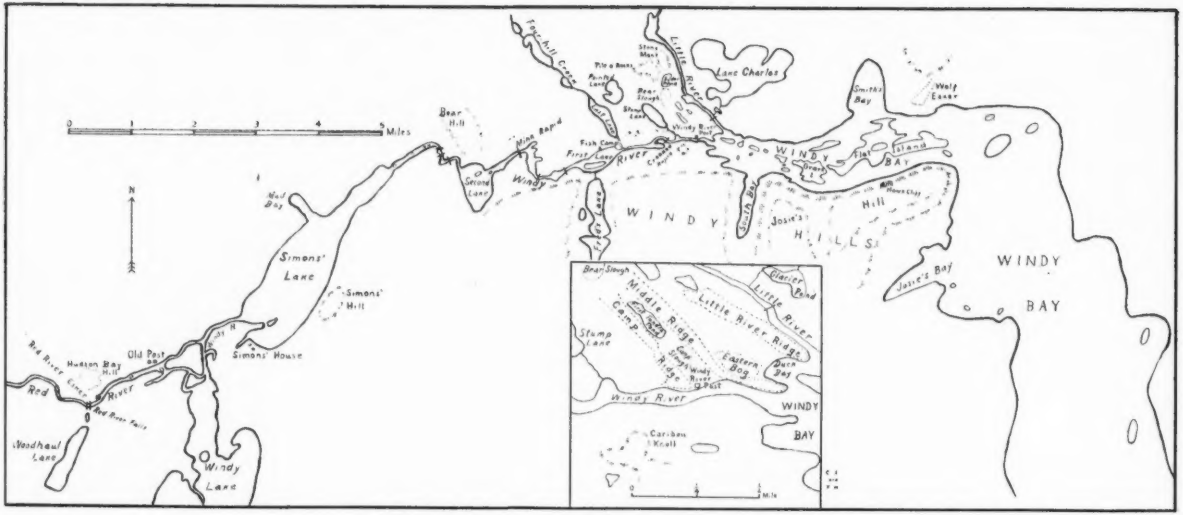

Fig. 1.—The Windy River area at the northwestern extremity of Nueltin Lake

exploration, *A Journey from Prince of Wales's Fort in Hudson's Bay, to the Northern Ocean . . . in the Years 1769, 1770, 1771, & 1772*. Hearne had crossed Nueltin Lake in the winter of 1770-71, but among many natural history notes made on his great journey, few pertain to this part of it. The first definite records of the local birds were contributed by P. G. Downes (1943), in his narrative of a canoe journey to this lake in 1939; but only a few of the commoner species are mentioned. In 1930 A. E. Porsild, in the course of a botanical reconnaissance on the upper Tha-anne River, Yathkyed Lake, and the lower Kazan River, kept notes on the birds observed, and these have been utilized to some extent by C. H. D. Clarke (1940) and T. H. Manning (1948). Manning himself, traveling by air in the summer of 1945, made brief stops at 19 localities in northern Manitoba and southern Keewatin, most of them never before touched by a naturalist. His nearest station to Nueltin Lake was Boulder Lake, lying only about 8 miles to the east. At the start of my trip in 1947 I was not even aware of his work, and his report on the birds and mammals was not published till the following year (1948). His paper comprises most of the information hitherto available on the avifauna of the hinterland on the west side of Hudson Bay, from the latitude of York Factory to Chesterfield Inlet.

Investigations in 1947.—The present report covers my field observations and collections during the period from May 20 to December 6, 1947. The bird records start on the former date, after I had left The Pas, Manitoba, for Churchill via the Hudson Bay Railway. I remained at Churchill from May 21 to 31, and then took off by plane for the northwestern extremity of Nueltin Lake (fig. 1). Here the little Windy River post (Harper, 1949: 225, 226, 228, 231, figs.), maintained by Charles Schweder and Fred Schweder, Jr., became my headquarters for more than six months. By far the greater part of my field work consisted of an intensive study of the area within a couple of miles of the mouth of Windy River. There were only three appreciable breaks in this program: a sojourn from July 10 to 20 at Josie's Bay (Harper, 1949: 226, fig.), a small arm of Windy Bay, 4 miles to the southeast; a nonstop plane trip on July 31 from Windy River to the upper Kazan River region and return; and a trip from October 13 to 22 up the Windy River for a distance of about 10 miles to Simon's Lake and vicinity. I had originally planned to wind up the season's operations at Nueltin Lake in September. However, by a fortuitous set of circumstances I was left very pleasantly marooned there till December 4, when I departed by plane for Churchill. Two days later I proceeded, again by air, to Winnipeg.

At Nueltin Lake I was enabled to record not only the arrival of all but the very earliest spring migrants, but also the gradual departure in the fall of all the summer residents, till a mere handful of winter residents remained. Few ornithologists have been located for a like period on the southern border of the Barren Grounds in western Canada. However, so much of my attention was devoted to other branches of natural history that ornithology, with all its charms, could claim only a modest share of the daily activities. Very little energy was spent on bird photography, since nearly all of the local species occur also at Churchill, that Mecca for photographers. About 130 specimens, representing 35 species, were collected, special attention being given

to recording the habitat, condition of gonads, colors of bare parts, weight, and ectoparasites.

Physiography and vegetation.—A few paragraphs must suffice here for a description of the local physiography and vegetation, since a more extended account is planned for later publication. The accompanying sketch map (fig. 1), crude as it may be, is at least an improvement (for the small area it covers) over the latest official map that has come to my attention (National Topographic Series, Nueltin Lake, Sheet 65 S. E., 1946). Air photographs so far available seem to have been taken along the 99th and 100th meridians, whereas my location was almost midway between these lines, and so is shown very inadequately in the photographs. Charles Schweder's cartographical talent contributed very materially to the construction of the present map; various field sketches and photographs from some of the higher elevations have also helped.

Perhaps an average of roughly 25 percent of the surface of the earth in this region is occupied by water—lakes, streams, and tundra ponds (fig. 4). The quiet bodies of water may be icebound for eight or nine months of the year; the streams, for about a month less. Nueltin Lake is represented on the maps as about 100 miles in length and about a dozen miles in maximum width (if various bays are disregarded); its elevation is estimated at 875 feet. The most imposing heights in the local terrain are the Windy Hills (Harper, 1949: 225, 231, figs.), a range extending along the south side of the head of Windy Bay and along the south side of Windy River to the vicinity of Simons' Lake—a total distance of about a dozen miles. Irregular spurs extend southward between Windy Bay and Windy Lake. Other high land appears to the eastward, toward the outlet of Nueltin Lake; but still farther to the east, between this lake and Hudson Bay, the terrain in general appears very flat to a traveler in a plane. The Windy Hills reach an estimated height of about 500 feet above the lake, or about 1400 feet above the sea. The country on the north side of Windy River (fig. 2), for a distance of some miles, is much lower than the Windy Hills, the highest points perhaps not exceeding 150 or 200 feet. Scarcely anywhere, outside of bogs and muskegs, can one find more than a few acres that are even comparatively level. Even there the surface is generally broken by numerous projecting boulders up to a rod or more in diameter; and at intervals there are ledges or outcrops or even mighty cliffs of bedrock. The general topography is an endless succession of hills and ridges, with intervening bogs and muskegs. The soil, for the most part, is gravelly; but at long intervals there are sandy eskers (fig. 3). The shores of lakes and rivers, in general, are rocky. In the bogs are peat and muck.

The Barren Grounds cover probably 80 to 90 percent of the land. The forested tracts consist primarily of black spruce and tamarack, with a much smaller amount of white spruce. The largest tract that came under my observation along the Windy River (fig. 5) was perhaps 2 miles in diameter. Only in particularly favored spots (perhaps where there is better protection from the strong winds) do the black spruce and the tamarack attain a height of more than 30 feet. There are also a few trees of canoe birch and balsam poplar. Along streams, and in such a deltalike area as at the head of Simons'

Lake, there are extensive thickets of willow (*Salix planifolia*). One of the most important plants of the region is dwarf birch (*Betula glandulosa*), which occurs both on the Barrens and in the timber, forming extensive thickets, from one to several feet in height. It provides food for Caribou, Arctic

Fig. 2.—A view eastward down the valley of Windy River, half a mile above its mouth. River bluffs with dwarf birch, crowberry, and scattered thickets of black spruce. August 8, 1947.

Fig. 3.—Low Barrens near the junction of Smith's and Windy Bays, with Wolf Esker in the disatnce. Black spruce, dwarf birch, narrow-leaved Labrador tea, mountain cranberry, reindeer lichen, moss, and grass. Charles Schweder (standing) and Anoteelik. June 12, 1947.

Hares, Ptarmigan, and Redpolls, shelter for various nesting birds, and shade or protection for many lesser plants. Important also are various low or prostrate, berry-bearing shrubs—*Vaccinium vitis-idaea, Vaccinium uliginosum,* and *Empetrum nigrum*—whose fruit helps to sustain bird, beast, and man through a large part of the year. Various lichens of the genus *Cladonia,* the so-called reindeer "moss," flourish ubiquitously and provide a staple food for the Caribou. These or other lichens fairly cover the earth, the rocks, and some of the trees and shrubs.

The summits and higher slopes of the hills and ridges are likely to form part of the Barren Grounds, while patches of spruce, tamarack, and dwarf birch nestle along the lower slopes or in the intervening depressions (figs. 2, 5, 6). The black spruce and the tamarack may form thickets on comparatively dry upland slopes, or they may flourish in muskegs (fig. 4) with an underfooting of sphagnum moss and a shrubby growth of Labrador tea (*Ledum groenlandicum* and *L. decumbens*), pale laurel (*Kalmia polifolia*), and bog rosemary (*Andromeda polifolia*).

Aside from the tree-grown muskegs, there are open, treeless bogs, containing more or less sphagnum, and largely covered with sedges (such as various species of *Carex, Eriophorum,* or *Scirpus*) and certain other herbaceous plants. Some of these bogs reveal bare patches of peat devoid of growing vegetation.

The interesting mixture of timber and Barrens (or forest and tundra) provides marvelous opportunities for the study of fauna and flora at one of the most significant zonal boundaries on the continent, in such various aspects as the advance or retreat of the forest, the interplay of forces promoting or retarding the development of Arctic Zone or Hudsonian Zone, the adaptive responses of organisms to one or both types of environment, and so on.

Perhaps few biologists who have not actually been there and looked over the ground with their own eyes can have a proper conception of the nature of the boundary between the Arctic and the Hudsonian Zones. It is anything but a sharply defined boundary, capable of being adequately represented on a map by a simple line. In a given longitude the farthest outposts of timber may be as much as 200 or 300 miles north of the southernmost patches of Barren Grounds. The so-called tree limit might be placed at either extreme, or else at some mid-point of the debatable ground. This doubtless accounts for the wide variation in its position on different maps. If the boundary must be indicated by a line, it might be placed in a position where approximately more than 50 percent of the land on one side is Barren Grounds and more than 50 percent of the land on the other side is forest. But perhaps the most satisfactory method of representation would be a broad band occupying the entire territory between the two extremes; within this band, dots representing units of forests would normally be thickest toward the southern border, and would dwindle toward, and finally disappear at, the northern border. (For remarks on the mixture of the Arctic and the Hudsonian Zones in the Ungava Peninsula, see the final paragraphs in the account of *Lagopus lagopus albus.*)

Birds and lichens.—A certain relation existing between members of these two groups of organisms is apparently well-known to lichenologists, but, as far as I am aware, it has been quite overlooked by American ornithologists. At Nueltin Lake my attention was attracted to some patches of a lichen of

a bright rusty-orange color. They seemed to occur only on certain large boulders at long intervals; in fact, I recall having noticed only three or four such boulders during the entire season. When Mr. W. L. Dix identified my specimens of the lichen as *Xanthoria candelaria* (L.) Kickx., a reason for its sporadic occurrence came to light. For Porsild, in discussing the flora of the Barren Grounds, remarks (1937: 137): "Here and there where boulders or erratics, left by the glaciers, offer a perching place for snowy owls, hawks or

Fig. 4.—First Tundra Pond, near mouth of Windy River, with bordering muskeg of black spruce, tamarack, and dwarf birch. September 16, 1947

Fig. 5.—A view northwestward over the valley of Windy River from the Windy Hills. Black spruce, tamarack, willow, and dwarf birch in the foreground. An extensive tract of black spruce on the distant hills, beyond Four-hill Creek. November 30, 1947.

other birds, the dung-loving, bright yellow or vermilion *Xantheria* [= *Xanthoria*] grows in profusion." If the lichen is dependent for its growth on the presence of bird dung, this would explain why its occurrence is more or less restricted to the large, prominent boulders that large birds seek for their resting-places and lookout points. Allen (1946: pl. 6) has published a Kodachrome of a Herring Gull on a habitual rock perch in a lake at Churchill, including a patch of lichen that is perhaps *Xanthoria*. A number of other lichens, including *Caloplaca elegans* (Link.) Th. Fr., thrive on the dung that accumulates on the nesting cliffs of maritime birds in the Arctic. Lynge (1941: 119) applies to such species the term "ornithocoprophilous." He remarks further (p. 100) on the variety of lichens in this category that may be found on the nesting cliffs. (See also Perez-Llano, 1944: 25.)

In the Nueltin Lake region I should consider the Herring Gull, the Rough-legged Hawk, the Snowy Owl, and the Raven as probably among the chief promoters of the growth of *Xanthoria*. Perhaps the ornithocoprophilous lichens are dispersed in part through transport of their soredia on the feet of such birds. Smaller and more timid birds, such as various species of Fringillidae, are doubtless less likely to expose themselves on the large boulders that attract the predatory types.

Names of plants.—In the present paper various plant species are mentioned, sometimes by their technical names, sometimes by common names. To facilitate their more complete identification (especially for the layman), a list of such plants, with both technical and common names, is here appended. Comprehensive reports on the local flora have appeared, the vascular plants being treated by A. E. Porsild (1950), the mosses by Edwin B. Bartram (1950), and the lichens and hepatics by W. L. Dix (1951).

Mosses	
Sphagnum spp.	Sphagnum moss[1]
Polytrichum piliferum	Hair-cap moss
Lichens	
Cladonia spp.	Reindeer lichen or "moss"
Caloplaca elegans	An ornithocoprophilous lichen
Xanthoria candelaria	An ornithocoprophilous lichen
Vascular Plants	
Pinus banksiana	Jack pine
Larix laricina	Tamarack
Picea glauca	White spruce
Picea mariana	Black spruce
Calamagrostis canadensis	Blue-joint grass
Eriophorum spp.	Cotton grass
Scirpus caespitosus	Tufted club rush
Carex spp.	Sedge
Salix planifolia and other species	Willow
Populus tacamahacca	Balsam poplar
Betula glandulosa	Dwarf birch
Betula papyrifera var. *neoalaskana*	Canoe birch
Alnus crispa	Green alder
Empetrum nigrum	Crowberry

1 It is possible that some of the mosses referred to in my notes as "sphagnum" belong actually to other genera.

Ledum decumbens	Narrow-leaved Labrador tea
Ledum groenlandicum	Common Labrador tea
Loiseleuria procumbens	Alpine azalea
Kalmia polifolia	Pale laurel
Andromeda polifolia	Bog rosemary
Arctostaphylos uva-ursi	Common bearberry
Arctostaphylos alpina	Alpine bearberry
Vaccinium uliginosum	Bog bilberry
Vaccinium vitis-idaea var. *minus*	Mountain cranberry

Comparison of littoral and inland avifaunas.—The Hudson Bay littoral, with its wide tidal flats, its mixture of fresh, brackish, and salt water, and its apparently abundant fish and invertebrate fauna, evidently offers far better conditions for a breeding population of water birds and shore birds than does the Nueltin Lake region. The loons, the geese, and most of the ducks and shore birds are not at all common in the latter region. In the case of the shore birds, there may be an insufficiency of marshes (other than sedge bogs) and of shallow-water feeding grounds on the margins of lakes and streams. Among the aquatic species that are more or less common as breeders at Churchill, but apparently absent as breeders in the Windy River area, some of the striking examples are the following:

Porzana carolina	Sora
Pluvialis dominica dominica	American Golden Plover
Numenius phaeopus hudsonicus	Hudsonian Curlew
Tringa solitaria cinnamomea	Western Solitary Sandpiper
Erolia alpina pacifica	American Red-backed Sandpiper
Micropalama himantopus	Stilt Sandpiper
Ereunetes pusillus	Semipalmated Sandpiper
Lobipes lobatus	Northern Phalarope
Stercorarius parasiticus	Parasitic Jaeger
Larus philadelphia	Bonaparte's Gull

There are also several small land birds with a similar status:

Regulus calendula calendula	Eastern Ruby-crowned Kinglet
Vermivora peregrina	Tennessee Warbler
Dendroica petechia amnicola	Northern Yellow Warbler

The situation of Churchill on the immediate shore of such a large body of cold water as Hudson Bay naturally tends to keep its summer temperatures lower than those at inland points in the same latitude. However, the situation of the Windy River area some 175 miles inland from the bay is offset by the fact of its being about 150 miles farther north than Churchill. Since both areas are on the southern borders of the Barren Grounds, it may be assumed that both have approximately equal summer temperatures. It is interesting to note how very few birds range in summer northward to the Windy River without having a similar status at Churchill. Almost the only ones are:

Mergus merganser americanus	American Merganser
Larus delawarensis	Ring-billed Gull

In each of these two cases it is probably a preference for inland breeding waters, rather than a difference in temperature requirements, that accounts for their summer occurrence in one area and their absence or extreme scarcity in the other. There is a single June record of the American Merganser at Churchill (Grinnell and Palmer, 1941: 48).

Postjuvenal molt, skull granulation, and migration.—In immature passerine

birds of this region, there seems to be an interesting correlation between the postjuvenal molt, the commencement of granulation of the skull, and fall migration. The following data were obtained from representatives of the genera *Turdus, Hylocichla, Anthus, Acanthis, Passerculus, Spizella, Zonotrichia, Calcarius,* and *Plectrophenax.* None of the specimens revealed any granulation of the skull while remaining in the juvenal plumage. The latest dates on which juvenile specimens of the various species were collected or observed were: *Turdus m. migratorius,* September 12 (reported by Charles Schweder); *Hylocichla m. minima,* August 17; *Anthus r. rubescens,* August 12 (and possibly 29); *Acanthis hornemanni exilipes,* August 7; *Acanthis l. linaria,* August 6; *Passerculus sandwichensis oblitus,* August 15; *Spizella a. arborea,* September 3; *Zonotrichia querula,* August 6 to 15 (postjuvenal molt commencing, but skulls still not granulated); *Zonotrichia (gambelii?),* August 7; *Calcarius l. lapponicus,* August 8. After the postjuvenal molt, when the first winter plumage had been assumed, the skulls had not become more than one-quarter granulated in the following: *Turdus m. migratorius,* September 25; *Zonotrichia (gambelii?),* August 23 and 28. By October 11, however, the skull of a *Plectrophenax n. nivalis* had become one-third granulated.

In most species the juvenal plumage seems to have been retained only till about the middle of August, when the birds may have had an average age of about six weeks.[2] The juvenile *Turdus* of September 12 and the juvenile *Spizella* of September 3 possibly came from second layings of eggs, after loss of the first sets. It appears likely that granulation of the skull does not commence till about the time when the somewhat long-drawn-out postjuvenal molt is completed; but further investigation is required for a more definite determination of this point. I am also much inclined to believe, from this season's experience, that the birds of the year remain in their natal territory until the postjuvenal molt is completed; in other words, that they do not undertake to migrate until after they have acquired the first winter plumage. If this is actually the case, then any locality (at least in the Arctic or the Subarctic) where birds are found in juvenal plumage in late summer, may be considered a part of the breeding range of the species concerned. Certain remarks by Thomson (1926) have a definite bearing on this situation: "In many cases migration seems to follow moulting" (p. 289). "The advent of this unrest [the prelude to migration] may . . . be conditioned by . . . the necessity . . . of delaying until the autumn moult is over" (p. 294).

In species having a streaked juvenal plumage but an unstreaked first winter plumage, the transition from one to the other is obvious enough; but in species that are streaked in both of these plumages (*e. g., Passerculus sandwichensis* and *Melospiza melodia*), the condition of the skull should be a useful criterion in determining which plumage is represented in a given specimen. The difficulty that Sutton (1935) has pointed out, in determining the exact stage of immature plumage in various sparrows, might conceivably le lessened by recording the degree of granulation of the skull in every specimen.

Comparative abundance of species.—While in the field, I made it a practice to record, as far as was feasible, the number of individuals of each species

2 In a captive *Spizella p. passerina* studied by Sutton (1937: 5), "the streaked feathers of the underparts" were "all gone" at an age of 45 days.

that I saw or heard each day. Unquestionably many of the same individuals in the vicinity of camp were thus recorded over again on different days. However, a compilation of the results, even if including many such "repeats" or multiple countings, should give a reasonably accurate indication of the comparative abundance of the various species. In this compilation I have utilized also a considerable number of reports furnished me by Charles Schweder and Fred Schweder, Jr., concerning their independent observations.

The total numbers of individual occurrences recorded for the most numerous species were approximately as follows:

Lagopus lagopus albus	1,757	*Anthus rubescens rubescens*	106
Larus argentatus smithsonianus	432	*Eremophila alpestris hoyti*	105
Zonotrichia querula	255	*Zonotrichia nigrilora* / *Zonotrichia gambelii* combined	101
Corvus corax principalis	171		
Turdus migratorius migratorius	166	*Mergus serrator serrator*	86
Spizella arborea arborea	152	*Buteo lagopus sancti-johannis*	81
Lagopus mutus rupestris	149	*Perisoreus canadensis canadensis*	76
Anas acuta tzitzihoa	131	*Euphagus carolinus carolinus*	70
Passerculus sandwichensis oblitus	127	*Acanthis linaria linaria*	63
Hylocichla minima minima	108	*Actitis macularia*	51

In this connection *Plectrophenax nivalis nivalis* must also be mentioned. Although I myself happened to note only about 30 individuals on the spring and fall migrations along the Windy River, the Schweder brothers, in their more extended travels, reported autumnal migrants numbering apparently some thousands of individuals; most of these were observed in the country extending between the Windy River and the upper Kazan River. Thus the Snow Bunting may be entitled to a place at the very head of the foregoing list.

None of the other bird species of the region furnished a record of as many as 50 individual occurrences during the entire season.

Summation of distributional records.—At the close of the account of each species I have listed some of the more important distributional records from the neighboring regions of northwestern Canada. Apparently there has been, for most of the species, no such comprehensive summation since the monumental works of Preble (1902, 1908). The territory covered extends, in a general way, north to Melville Island and Lancaster Sound; east to the northern tip of Baffin Island, Melville Peninsula, Southampton Island, and the west coast of Hudson Bay; south to Churchill (or York Factory in some cases) and Reindeer and Athabaska Lakes; and west to a line extending from the Slave River northward through the North Arm of Great Slave Lake, Great Bear Lake, and the Anderson River region. The aim has been to bring up to date, in one place, our knowledge of the general and zonal distribution, in this part of Canada, of the species discussed. Particular attention has been paid to records from that stretch of country where the stunted forests of the Hudsonian Zone give way gradually to the Barren Grounds of the Arctic Zone; for this constitutes one of the most important or striking of faunal and floral boundaries in North America, and our knowledge of avian distribution along this boundary is still fragmentary.

To save time and space, I have not usually cited the works published prior to those of Preble (1902, 1908), since he himself has amply compiled

the records of his predecessors. Thus the localities mentioned in connection with the references to his papers are partly secondary records derived from the earlier authors, and partly Preble's own records. For distributional data published in the years subsequent to Preble's papers, I generally give only the earliest reference, though a certain amount of duplication in the references has been scarcely avoidable. The distribution of birds at Churchill has such an important bearing on, or relation to, their distribution in the Nueltin Lake region, that I give for nearly every species a reference to Taverner and Sutton's comprehensive work (1934) on the Churchill area.

Nomenclature.—In all but a few cases I have employed the technical nomenclature of the A. O. U. *Check-List,* Fourth Edition (1931), and its several supplements (1944, 1945, 1946, 1947, 1948, 1949). The exceptions are explained in the text. These are due for the most part to my adherence to the International Rules of Zoological Nomenclature as a higher authority than the A. O. U. Code. The A. O. U. Committee on Classification and Nomenclature purports (*Auk* 64 (3): 445-446, 1947) to uphold the International Rules, but has not done so invariably.

In omitting the hyphen from such words as Yellowlegs, Graycheek, Blackpoll, and Whitethroat, I follow the high authority of Webtser's *New International Dictionary,* the *Style Book* of the Government Printing Office, and Alice M. Ball's *Compounding in the English Language* (1939). On this point the compilers of the A. O. U. *Check-List,* through its various editions, have exhibited a curious indifference to, or lack of familiarity with, such authorities.

On the principle that the name of an author should be cited as it appears on the title-page of his publication (except in case of typographical error), I cite the author of the *Systema Naturae,* Tenth Edition (1758), as Linnaeus, and that of the Twelfth Edition of the same work (1766) as Linné.

Measurements.—Linear measurements are expressed in millimeters. Wing measurements represents the chord of the closed wing, as defined and illustrated by Baldwin, Oberholser, and Worley (1931: 76, figs. 100, 101). The primaries are numbered from the outer edge of the wing inward, the outermost one being considered the first, as explained by the authors just cited (p. 88).

Plumages.—The juvenal plumage is the one that succeeds the natal down; in passerine and certain other birds it is followed (generally in a few weeks' time) by the first winter plumage. This postjuvenal molt takes place, as a rule, in late summer or early autumn. The term "juvenile" is applied herein to birds wearing the juvenal plumage.

In the descriptions of plumages, color terms, when derived from Ridgway (1912), are capitalized.

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I can scarcely make sufficient acknowledgment of the generous and capable assistance and the very thoughtful consideration and hospitality extended to me by Charles Schweder and Fred Schweder, Jr., during my six-months sojourn at the lonely Windy River post. Their comprehensive knowledge of the avifauna of that area, fostered by the possession of Peterson's *Field Guide to the Birds* (*cf.* Downes, 1943: 236) and Taverner's *Birds of Western Canada* and freely shared with me, has added materially to whatever value the present report may have. The children of the post—10-year-old Michael Schweder and two Eskimos, 15-year-old Anoteelik and 5-year-old Rita—were also helpful in numerous ways. They all have my lasting gratitude.

In midsummer Dr. Robert F. Yule, of the Department of National Health and Welfare, came twice to the Windy River post, while en route to make a medical inspection of the Eskimos on the upper Kazan River. He was accompanied by Mrs. Yule, in a plane flown by Thomas Lamb, of The Pas. Their brief visits provided a most welcome break in the season's routine at the post, besides an opportunity to send out mail and to secure a few small but much needed supplies.

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Mr. James Bond and Dr. Ralph S. Palmer have kindly read the manuscript and given me the benefit of many valuable suggestions.

ACCOUNTS OF SPECIES

Gavia immer (Brünnich), Common Loon.—Only two single and silent individuals came under my observation: one in an opening in the ice on Windy Bay, June 12, and the other on the same bay, July 24. In the experience of Charles Schweder and Fred Schweder, Jr., this species is locally less common than the Pacific and the Red-throated Loons. They have noticed it chiefly in Nueltin Lake, but once in a small lake halfway to the upper Kazan River. They have not observed any nests or downy young ones about Nueltin Lake. They say that the Crees in the Reindeer Lake region are very fond of the flesh of loons, and will eat them whenever they can secure them.

To the eastward, the Common Loon has been recorded at Churchill

(Preble, 1902: 75; Taverner and Sutton, 1934: 10), Eskimo Point (Hørring, 1937: 36), and Neck, Sandhill, Carr, Ninety-seven, and Twin Lakes (Manning, 1948: 8); to the northward, at Baker Lake (Hørring, 1937: 36) and in the Perry River district (Gavin, 1947: 197; no mention being made of the more likely *G. adamsi*); to the westward and northwestward, at Great Slave and Clinton-Golden Lakes (Preble, 1908: 254, and 1911: 359), Horton River, Langton Bay, and Coronation Gulf (Anderson, 1913: 456), Artillery Lake (Blanchet, 1925: 52), and Thelon River (Critchell-Bullock, 1931: 12); and to the southward, at Reindeer Lake and Cochrane River (Buchanan, 1920: 221). Rand (1947: 193-195) maintains that it is impractical to recognize the subspecies *G. i. elasson* Bishop, and Palmer (1949: 21-23) makes similar remarks.

Gavia adamsi (Gray), Yellow-billed Loon.—On June 14 a Yellow-billed Loon, the first known to occur in the Nueltin Lake region, flew up from a small expansion of Little River 2 miles above its mouth. The wind being unfavorable, the bird did not gain sufficient headway and came down on the land, where it was secured by Fred Schweder, Jr. No ectoparasites were found on it.

To the northward, the Yellow-billed Loon has been recorded at Boothia (Preble, 1902: 76), Kent Peninsula (Hørring, 1937: 37), Baker and Yathkyed Lakes and lower Kazan River (Clarke, 1940: 40), and Somerset Island and Melville Peninsula (Shortt and Peters, 1942: 339); to the westward and northwestward at Athabaska and Great Slave Lakes and Franklin and Liverpool Bays (Preble, 1908: 256), Artillery, Ptarmigan (Casba), Clinton-Colden, and Aylmer Lakes (Preble, 1911: 360), Coronation Gulf (Anderson, 1913: 456), and Lac de Gras (Blanchet, 1926b: 50).

Gavia arctica pacifica (Lawrence), Pacific Loon.—In distinguishing this species from the Red-throated Loon, especially when the birds were awing and at a distance, I relied largely upon the notes, as I had learned them in the Athabaska-Mackenzie region many years ago. There seems, however, to be rather meager information in the literature that one may depend upon for any clear-cut distinction between certain calls of the two species. My notes for 1914 refer to the flight call of the Pacific Loon as "a rapid cry of *qua-qua-qua-qua-qua*, etc., somewhat suggesting the hoarse quack of a duck." In 1920 I noted it as a "hoarse, guttural *quar-quar-quar-quar-quar*." In 1947 I represented this call as "a coarse, guttural *garr, garr, garr*" (or *gwar, gwar, gwar*). It is apparently uttered in a series of some length. The birds were seen on five occasions, from June 5 to September 5. In every case they were on the wing and giving the above-described flight call. Their habit of calling frequently, or regularly, on the wing may tend to distinguish them from the Red-throated Loon.

The first bird passed on June 5, when the river at camp had begun to break its icy fetters. On June 12, when a small area of open water had appeared on Windy Bay, a migrant flock of eight birds passed over. One or two were seen on June 14, two on August 6, and three on September 5. Thus a total of about 15 birds was recorded during the season. They flew unhesitatingly above the land as well as over the water. The three birds of September 5, perhaps on their fall migration, were flying southeasterly down

the valley of Little River at a height of 100-150 feet. In this connection it may be relevant to recall that I noted from one to several trios of Pacific Loons, apparently migrating, on Lake Athabaska on August 24, 1920. It would be interesting to know whether these trios represent family parties, and if so, whether they comprise two adults with a young one or an adult female with two young ones.

The Pacific Loon has been recorded to the eastward at Churchill (Preble, 1902: 76; Taverner and Sutton, 1934: 11), at or near Eskimo Point (Preble, 1902: 76; Hørring, 1937: 38), at Tavane (Blanchet, 1930: 62), at Chesterfield and Nunalla (Sutton, 1931: 156), at Southampton Island (Sutton, 1932: 13), and at Camp, Carr, and Twin Lakes (Manning, 1948: 9); to the northward, from Beverly to Schultz Lakes (Critchell-Bullock, 1931: 12), near Baker Lake and at Repulse Bay, King William Land, and Kent Peninsula (Hørring, 1937: 38), at Aberdeen and Yathkyed Lakes and Thelon and lower Kazan Rivers (Clarke, 1940: 40), at Arctic Bay and Pond Inlet (Shortt and Peters, 1942: 339), in Fury and Hecla Strait (Bray, 1943: 506), and in the Perry River district (Gavin, 1947: 197); to the westward and northwestward, at Great Slave and Great Bear Lakes, Anderson River, and Franklin and Liverpool Boys (Preble, 1908: 257), at Clinton-Colden and Aylmer Lakes (Preble, 1911: 360), and at Coronation Gulf and Cape Bathurst (Anderson, 1913: 456).

Gavia stellata (Pontoppidan), Red-throated Loon.—To judge by my experience in 1947, as well as in previous years in the Athabaska and Great Slave Lakes region, this species calls on the water more frequently than on the wing. My notes of 1914 refer to one of its calls as "an exceedingly coarse, gruff *quar, quar*"; again as "*g-r-r, g-r-r, ga* (or *quar-quar-qua*)" (*cf.* Nelson, 1887: 37). Apparently this call (which I did not hear at all in 1947) consists of just three notes, the third differing from the first two, whereas the flight call of the Pacific Loon consists of an indefinite series of more or less identical notes.

On June 23 a single bird was seen on Little River. It was thrusting its head beneath the surface, in a manner characteristic of loons and mergansers, obviously for the purpose of detecting fish before diving in pursuit of them. On July 22 two Red-throated Loons together were exhibiting the same habit in a little bay on Windy River. After one flew off, the other remained for a time and gave an uncanny cry of *owhh, owhh, owhh!* A few minutes later I found a dead Grayling (*Thymallus signifer*), about 5½ inches long, floating in the bay near where the birds had been. Its head was half digested, and I wondered if it might have been regurgitated by one of the birds in agitation at my approach. On August 25 single birds were seen on Windy River and on Little River. Single loons, perhaps but not certainly of this species, were seen on June 26 (flying near Little River) and on September 11 (on Windy Bay). No more than about seven individuals were observed during the season. In contradistinction to the Pacific Loon, the majority of these birds were seen on the water, and the one or two seen on the wing were silent.

Fred Schweder, Jr., once saw young Red-throated Loons on a lake some 20 miles north of Windy River, and he once found a bird of this species in a gill-net at the mouth of this river. Charles Schweder reported two young ones in a previous year near Simons' Lake, on a lake of such limited extent

that the adults could rise from it only in a brisk wind. He considers this species as generally common in the Nueltin Lake region.

Some of the numerous earlier records are the following: to the eastward, at Churchill and 25 and 50 miles south of Eskimo Point (Preble, 1902: 77), Tavane (Blanchet, 1930: 62), Chesterfield (Sutton, 1931: 156), Southampton Island (Sutton, 1932: 18), and Twin Lake (Manning, 1948: 9); to the northward, at Aberdeen Lake (Critchell-Bullock, 1931: 12), Kent Peninsula, King William Land, and Chesterfield and Wager Inlets (Høtring, 1937: 39), Baker and Yathkyed Lakes and (lower) Kazan River (Clarke, 1940: 40), Somerset Island and Pond Inlet (Shortt and Peters, 1942: 339), Melville Peninsula (Bray, 1943: 506), and Perry River district (Gavin, 1947: 197); to the westward and northwestward, at Great Slave, Artillery, Ptarmigan (Casba), Clinton-Colden, and Aylmer Lakes (Preble, 1911: 360), Coronation Gulf and Cape Bathurst (Anderson, 1913: 457), and lower Hanbury River and Sifton Lake (Critchell-Bullock, 1931: 12); and to the southward, at Reindeer and Du Brochet Lakes and Cochrane River (Buchanan, 1920: 221).

Colymbus auritus Linnaeus, Horned Grebe.—According to Charles Schweder, two individuals formerly came every year to nest on a lake near the Old Post, 2 miles southwest of Simons' Lake. One or two young ones were seen in various years, and once four eggs were found.

The Horned Grebe has been recorded at Churchill (Preble, 1902: 75; Taverner and Sutton, 1934: 13), at Athabaska and Great Slave Lakes, and on the Anderson River (Preble, 1908: 253). Apparently it scarcely extends into the Barren Grounds, although there is a problematical record from Smart Lake (Critchell-Bullock, 1931: 12).

Ardea herodias herodias Linnaeus, Great Blue Heron.—Charles Schweder spoke of having seen two of these birds about 1942 on South Bay. This is far beyond the normal range of the species.

Botaurus lentiginosus (Montagu), American Bittern.—On May 20, from the train, I saw an American Bittern at Cormorant Lake, Manitoba. Charles Schweder reported having seen a single bird at the south end of Nueltin Lake in the spring of 1946.

There are records from Churchill (Preble, 1902: 91; Taverner and Sutton, 1934: 13), Athabaska and Great Slave Lakes (Preble, 1908: 311), and Reindeer River (Buchanan, 1920: 31).

Cygnus columbianus (Ord), Whistling Swan.—On May 30 eight Whistling Swans, led by two geese (*Branta canadensis* subsp.), flew west-northwest past Landing Lake, a few miles southeast of Churchill. On October 15 a band of three Swans, flying on a southwest course, alighted on Simons' Lake. After resting for a little more than an hour, they left for the south, traveling high and softly calling *hoot*.

Charles Schweder reports the speices as scarce in this region. About 1937 two were seen at Simons' Lake in summer (July). In September, 1944, about 60 were seen traveling southward in company with geese (this observation probably near Windy River). Evidently the Nueltin Lake region does not lie on one of the main migratory highways of the Whistling Swan.

To the eastward the species has been recorded at or near Churchill (Preble, 1902: 91; Taverner and Sutton, 1934: 14), at Eskimo Point (Hørring, 1937: 7), Tavane (Blanchet, 1930: 62), and Southampton Island (Sutton, 1932: 25); to the northward, at Cambridge Bay and Kent Peninsula (Preble, 1908: 309), Baker Lake and Wager Inlet (Hørring, 1937: 7), Iglulik Island (Bray, 1943: 509), Repulse Bay (Manning, in Bray, 1943: 509), and in the Perry River district (Gavin, 1947: 197); to the westward and northwestward, at Athabaska, Great Slave, and Great Bear Lakes, Fort Anderson, and Franklin Bay (Preble, 1908: 309), and near Campbell Lake and on the Thelon River (Critchell-Bullock, 1931: 14).

Branta canadensis (Linnaeus) subspp., Canada Goose.—On May 21 four flocks of geese, apparently of this species, and numbering 2, approximately 16, 2, and 3 individuals, were seen from the train near miles 361, 423, 450, and 485 of the Hudson Bay Railway (between Amery and Bylot, Manitoba). On May 30 two pairs were noted at Landing Lake, southeast of Churchill—one traveling with eight Whistling Swans, the other on the ground. The next day a pair was seen again on the ground at Landing Lake.

On June 6 Charles Schweder reported about 20 Canada Geese on a sedge bog near the mouth of Windy River. He has known a single pair to breed for a number of years in a marshy area above Simons' Lake. He spoke of observing about half a dozen flocks of geese (apparently the present species) passing southward, high up, in the Windy River area between September 11 and 23; the average size of the flocks was about 100. In his experience they usually pass southward after a northwest storm, with snow. In the absence of specimens, little can be said concerning the subspecific identity of the local birds.

Many of the records in the literature (particularly the older ones and those pertaining to birds on migration) can not be safely allocated to the various subspecies now recognized. Aldrich (1946: 100-101) lists specimens of *B. c. interior* from the east side of James and Hudson Bays; of *B. c. leucopareia*, from Franklin Bay, Victoria Island, Dolphin and Union Strait, Great Bear Lake, Thelon River, Baffin Island, Cape Fullerton, and lower Kazan River; and of *B. c. parvipes*, from Athabaska River, Lake Athabaska, and Mackenzie River. Other records, published under a variety of binomial and trinomial designations, are from the following localities: Repulse Bay and Churchill River (Preble, 1902: 90); Great Slave Lake, Anderson, Coppermine, and Back Rivers, Cambridge Bay, and Boothia (Preble, 1908: 304, 306); Artillery Lake (Preble, 1911: 370); Sifton and Beverly Lakes (Critchell-Bullock, 1931: 14); Hanbury River and Clinton-Colden and Dubawnt Lakes (Clarke, 1940: 41); Perry River district (Gavin, 1947: 197); Southampton Island (Sutton, 1932: 31); Tavane (Blanchet, 1930: 61); Churchill (Taverner and Sutton, 1934: 15); Baker Lake, Eskimo Point, and Roe's Welcome (Hørring, 1937: 23); Big Sand, Neck, Sandhill, Camp, and Carr Lakes (Manning, 1948: 10); and Cochrane River (Buchanan, 1920: 231).

Charles Schweder mentioned having rarely observed some very small gray geese—"Laughing Geese," as he called them. Possibly these were *B. hutch-*

insii hutchinsii. The localities were presumably in the Windy River or adjacent areas.

Anser albifrons (Scopoli), subsp., White-fronted Goose.—On June 9 Fred Schweder, Jr., secured a White-fronted Goose on Stump Lake, near the mouth of Windy River.

This species has been recorded to the eastward at Churchill (Preble, 1902: 89; Taverner and Sutton, 1934: 16); to the northward, on Back's River (Preble, 1908: 302), on King William Island (Hørring, 1937: 21), and in the Perry River district (Gavin, 1947: 198); to the westward and northwestward, at Great Slave and Great Bear Lakes, Fort Enterprise, Coppermine River, Franklin and Liverpool Bays, and Coronation Gulf (Preble, 1908: 302), Athabaska and Aylmer Lakes (Preble, 1911: 369), Outram River and Lake MacKay (Blanchet, 1925: 52), and Hanbury and Thelon Rivers (Critchell-Bullock, 1931: 14).

Chen hyperborea hyperborea (Pallas), Lesser Snow Goose.—On September 6—a dark, cloudy, raw day with snow flurries, a brisk northwest wind, and temperatures just above the freezing point—a flock of about 25 white geese, with black wing tips, passed southward directly over camp at a height of about 500 feet. They were in more or less of a V-formation, and were giving the *quonk, quonk, quonk* note characteristic of Lesser Snow Geese. About an hour previously a flock of some 40 geese, possibly of the same species but not identifiable at a distance of a mile, had passed southward over South Bay, at a similar altitude and in a similar formation.

In September, 1946, Charles Schweder had noted a migrant flock of about 100 Snow Geese stopping for a day near the upper Kazan River. He had never observed any passing northward in the spring.

There are records of this Snow Goose to the eastward at Churchill (Preble, 1902: 89) and at Fullerton and on Southhampton Island (Sutton, 1932: 44); to the northward, on Banks, Melville, and Victoria (Wollaston) Islands (Preble, 1908: 297), Bylot Island, Baker Lake, and the lower Kazan River (Hørring, 1937: 20), Beverly Lake (Clarke, 1940: 42), Admiralty Inlet (Bray, 1943: 510), and in the Perry River district (Gavin, 1947: 198); to the westward and northwestward, at Athabaska, Great Slave, Great Bear, MacKay, Winter, and Point Lakes, Fort Anderson, and Liverpool Bay (Preble, 1908: 297, 300), at Cape Bathurst, Banks Island, Langton Bay, and Coronation Gulf (Anderson, 1913: 466), and at Campbell Lake and the lower Thelon River (Critchell-Bullock, 1931: 14).

Anas platyrhynchos platyrhynchos Linnaeus, Common Mallard.—A flock of three ducks, flying up the Windy River at its mouth on September 10, had the appearance of Mallards and were identified as such by Fred Schweder, Jr. According to Charles Schweder, a few Mallards nest in the marshes of Windy River; the young have been seen and shot in the fall. He used to hunt this species in some sand ponds northwest of Red River Falls.

The Mallard has been recorded to the eastward on the Barren Grounds north of Seal River (Preble, 1902: 82), at Churchill (Taverner and Sutton, 1934: 17), and approximately off Tavane (Shortt and Peters, 1942: 341); to the westward, at Athabaska and Great Slaves Lakes and Anderson River

(Preble, 1908: 277) and between Lake MacKay and Aylmer Lake (Blanchet. 1926b: 50); and to the southward, at Reindeer and Cochrane Rivers and Reindeer and Du Brochet Lakes (Buchanan, 1920: 227).

Anas rubripes Brewster, Black Duck.—I saw a flock of four ducks, apparently of this species, swimming on Windy River at its mouth on August 20. Two days later Fred Schweder, Jr., reported an adult bird with downy ducklings on Smith's Bay; he noted the white under side of the adult's wing, and considered it a Black Duck.

This species is generally scarce so far northward and westward. It has been found at Churchill (Preble, 1902: 83; Taverner and Sutton, 1934: 17) and at Nunalla (Sutton, 1931: 156); and it has even been reported on the Anderson River by MacFarlane (Preble, 1908: 278) and on the Finnie and Thelon Rivers (Clarke, 1940: 43).

Anas acuta tzitzihoa Vieillot, American Pintail.—In 1947 the Pintail appeared chiefly as a spring migrant in June; only one bird came under my observation after that month. The bulk of the birds (approximately 130 individuals) were seen from June 4 to 10, although Windy River did not break up till the 14th. At this season the Pintails were attracted to a little open water that was available in the sedge bogs. Here the first bird seen was a solitary male, but practically all the others were in flocks varying from 2 to 35 or 40 individuals. Several times the weak note of the male—*proop*—was heard from flocks on the bogs. The quack of the female was heard from a passing pair on June 12. On June 26 a female was seen on a tundra pond. On August 3 an adult female was collected in the edge of Windy River: maxilla dark plumbeous; mandible light plumbeous, darker toward tip, but nail light; iris dark olive; tarsus and toes plumbeous, webs darker; approximate weight, 1 1/3 lb. The following Mallophaga were found on it: *Anaticola crassicornis, Trinoton querquedulae,* and *Anatoecus* sp.

In some years Charles Schweder observes very few Pintails, although he considers it the commonest duck of the Windy River area. He finds it nesting far from the water, beneath a spruce or in a depression in an esker. He has seen the young many times. The Pintails breed at a series of sandy lakes about 8 miles west of Simons' Lake, and many of them are seen there in August and September. He once saw a flock of about 25 Pintails flying up the Windy River above Simons' Lake in early June. When a Duck Hawk came out of the timber and started in pursuit of one of the birds, the latter dropped to the water, where the hawk swooped at it two or three times. The Pintail, however, splashed water with its wings and thus managed to keep its pursuer at bay. Presently the Duck Hawk desisted.

The Pintail ventures well into the Barren Grounds at the breeding season. Eastward of Nueltin Lake, it has been recorded in the vicinity of Churchill (Preble, 1902: 84; Taverner and Sutton, 1934: 18); 50 miles south of Eskimo Point (Preble, 1902: 84), at Chesterfield, Eskimo Point, and Nunalla (Sutton, 1931: 156), at Southampton Island and Roe's Welcome (Sutton, 1932: 57), and at Boundary and Malaher Lakes (Manning, 1948: 10); northward, in the Perry River district (Gavin, 1947: 200; Hanson, Rogers, and Rogers, 1949: 201); westward and northwestward, at Athabaska, Great

Slave, and Great Bear Lakes and Anderson River (Preble, 1908: 283), at Cape Bathurst and Coronation Gulf (Anderson, 1913: 463), at Clinton-Colden Lake (Blanchet, 1925: 52), near Campbell Lake (Critchell-Bullock, 1931: 14), and at Artillery Lake and Hanbury and Thelon Rivers (Clarke, 1940: 43); and southward, at Du Brochet Lake (Buchanan, 1920: 230).

Anas carolinensis Gmelin, Green-winged Teal.—Two males and a female were seen on Windy River on June 12. They were probably in nuptial mood, for the *prreep* note of the male, characteristic of the breeding season, was heard from them. Two days later a male was seen flying up the river.

Charles Schweder considers the Greenwing not very common locally; in September, 1946, he found a very few on the upper Kazan River. Fred Schweder, Jr., has noted young ones in the vicinity of the Old Post, 2 miles southwest of Simons' Lake.

To the eastward, the species has been recorded at Churchill (Preble, 1902: 83; Taverner and Sutton, 1934: 19), 15 miles north of Seal River (Preble, 1902: 83), and at Nunalla (Sutton, 1931: 156); to the westward and northwestward, at Athabaska, Great Slave, and Great Bear Lakes and Fort Anderson (Preble, 1908: 280), Outram River and Lake MacKay (Blanchet, 1925: 52), and Thelon River (Clarke, 1940: 43); and to the southward, on Churchill River (Buchanan, 1920: 229).

Mareca americana (Gmelin), Baldpate.—Charles Schweder considers this a rather uncommon species in the Windy River area. On September 24 he reported two adults, and on the 25th seven young ones, unable to fly, on the river 2 miles above its mouth, where I myself saw a grown bird on the latter date. He spoke of having shot at a small flock (apparently on September 25) as it was passing at a height of about 10 feet above the river. Thereupon one of the birds, that had not been in the line of fire, plunged into the water and disappeared for about 5 seconds, when it emerged and flew off.

Fred Schweder, Jr., reported having seen a brood of young ones in July, 1944, near the Old Post, 2 miles southwest of Simons' Lake.

To the eastward the Baldpate has been found at Churchill (Preble, 1902: 83; Taverner and Sutton, 1934: 18); to the westward and northwestward, on Athabaska and Great Slave Lakes and Slave and Anderson Rivers (Preble, 1908: 279), at the mouth of Horton River (Anderson, 1913: 462), and east of Yellowknife (Hanson, Rogers, and Rogers, 1949: 201); and to the southward, north of Reindeer Lake (Buchanan, 1920: 229) and at Big Sand and Neck Lakes (Manning, 1948: 10). Apparently it has not been previously reported from Keewatin.

Spatula clypeata (Linnaeus), Shoveler.—The only Shovelers that Charles Schweder has found in the Nueltin Lake region were two that he shot about June, 1945, on Duck Bay.

This species occurs rather rarely as far north as the southern border of the Barren Grounds. On the east it has been recorded at Churchill (Taverner and Sutton, 1934: 20; Grinnell and Palmer, 1941: 48); on the west and northwest, at Athabaska, Great Slave, and Great Bear Lakes and Anderson River (Preble, 1908: 282) and mouth of Horton River (Anderson, 1913: 462); and on the south, at Big Sand Lake (Manning, 1948: 10).

Aythya marila nearctica Stejneger, Greater Scaup Duck.—The one adult Scaup secured proved to be a Greater. It is assumed, rather than assured, that most or all of the others seen were of the same species. While most of Nueltin Lake was still frozen, on June 12, six or eight Scaups were seen in a small open area on Windy Bay. The male of a pair observed on a tundra pond on June 22 looked large and was very white on the sides. The guttural note, *drrrh, drrrh,* was heard at this time. What was presumably the same male was seen on the same pond on June 27. On June 26 three males, which I suspected at the time of being Lesser Scaups, were seen on another tundra pond.

Anoteelik secured two downy ones (male and female) on July 17 by hurling stones at them. Two days later another (a female) was collected at the same place—the mouth of Little River. In these downies the maxilla was dusky olive; nail and mandible pale brownish; iris dark olive; tarsus and toes and sides of webs olive (or dark plumbeous); middle of webs dusky. The last specimen weighed 76.7 g.

On July 23 Fred Schweder, Jr., secured an adult female on Four-hill Creek: bill black, the nail, tomia, and mandible more or less plumbeous; iris pale yellow; tarsus and toes dark plumbeous; webs fuscous; exposed culmen, 43 mm.; wing, 213 mm.; approximate weight, 1¾ lb. The bird had been feeding upon three species of mollusks. In its throat were eight individuals and fragments of *Sphaerium* sp. and four *Gyraulus arcticus;* in its proventriculus and gizzard were a few recognizable shells of *Sphaerium* sp. and *Valvata lewisi* (Wurtz, 1949: 5).

On September 11 a flock of ten white-faced Scaups on Windy Bay probably represented nearly grown birds of the year.

In former years Charles Schweder hunted Greater Scaups at some sand ponds northwest of Red River Falls. He reported considerable numbers on the upper Kazan River in September, 1946.

Reports of this species in northwestern Canada are not overly numerous; its normal breeding range does not seem to extend appreciably into the Barren Grounds. In the Hudson Bay region it has been found at Churchill or vicinity (Preble, 1902: 85; Taverner and Sutton, 1934: 20) and at Southampton Island (one record, Sutton, 1932: 57); in the Athabaska-Mackenzie region, on Athabaska and Great Slave Lakes (Preble, 1908: 285), on Athabaska and Slave Rivers (Preble, 1911: 366), and on Hanbury River (Critchell-Bullock, 1931: 14).

Bucephala clangula americana (Bonaparte), American Goldeneye.—On June 24 and 26 I saw a pair of Goldeneyes on a tundra pond half a mile northwest of the mouth of Little River. On August 20 Anoteelik captured alive one of half a dozen downy ducklings that he found with the mother duck at the mouth of Little River, apparently on the shore. Its bill was fuscous; both nails horn color; iris pale olive; tarsus and toes yellowish olive; two outer toes with median dusky streak; webs dusky, yellowish olive at sides; weight, 156 g.; testes, about 4×1 mm. In the local absence of any tree large enough to furnish a nest-hole, the eggs may have been laid beneath the low branches of a spruce or in a cavity among rocks. This is perhaps the first breeding record for Keewatin.

As a boy, Charles Schweder hunted this species at some sand ponds northwest of Red River Falls.

The Goldeneye has been found at Churchill (Preble, 1902: 85; Taverner and Sutton, 1934: 21); a little north of Reindeer Lake (Buchanan, 1920: 230); and in the Athabaska-Mackenzie region at Fort Resolution and Fort Rae and on the Athabaska, Slave, and Mackenzie Rivers (Preble, 1908: 287).

Clangula hyemalis (Linnaeus), Old-squaw.—The first Old-squaw that came to my notice flew past our camp on June 5 and alighted in an open spot on the generally ice-bound Windy River. Another passed on June 10. On June 12 there were one or two at an opening in the ice of Windy Bay. A flock of four alighted on Windy River on the 14th—the day of the "break-up." On June 30 a male flew up from a tundra pond with a sonorous call of *onk-onk-oh-oh'-onk* (each "*o*" with the long sound), and repeated this as it circled a time or two before making off.

Charles Schweder reported Old-squaws as common on the upper Kazan River in September, 1946. The species has been recorded as breeding on Southampton Island and at Cape Fullerton (Sutton, 1932: 58), at Chesterfield (Sutton, 1931: 156), and from Churchill to Cape Churchill (Taverner and Sutton, 1934: 22); as occurring at Malaher, Boundary, and Carr Lakes and breeding at Camp and Victory Lakes (Manning, 1948: 10). Blanchet (1930: 61) found it at Tavane, Shortt and Peters (1942: 342) at Pond Inlet and Somerset Island, and Gavin (1947: 200) in the Perry River district. Hørring (1937: 8) mentions many localities in northern Keewatin, south to Baker and Yathkyed Lakes and Eskimo Point. The Old-squaw migrates through the Athabaska-Mackenzie region and breeds on the Barren Grounds of the mainland and on the Arctic islands to the northward (Preble, 1908: 289). Preble (1911: 367) also records it from Artillery Lake to Aylmer Lake; Critchell-Bullock (1931: 14), at Campbell Lake and between Lac du Bois and Radford and Street Lake; and Clarke (1940: 44), at Plover and Prairie Lakes (in the Thelon River region) and on the (lower) Kazan River.

Somateria spectabilis (Linnaeus), King Eider.—The first King Eider known to occur in the Nueltin Lake region was an immature male taken by Fred Schweder, Jr., on September 17, on a tundra pond a mile northwest of the mouth of Windy River. Its bill was plumbeous gray; periphery of mandibular nail horn color; iris olive-brown; tarsus and toes yellowish olive; middle of webs dusky; testes about 7×1 mm. The specimen was not very fat and weighed approximately 2 lbs. In its gullet as well as in its stomach were many fragments of an amphipod (*Gammarus lacustris* Sars), identified by C. R. Shoemaker. The stomach contained also a little gravel.

This species breeds on the Arctic coast and islands, south to Franklin and Liverpool Bays (Preble, 1908: 293), Cape Bathurst (Anderson, 1913: 465), Chesterfield (Sutton, 1931: 157), Southampton Island (Sutton, 1932: 71), and Baker Lake and Eskimo Point (Hørring, 1937: 15). Gavin (1947: 200) found it abundant in the Perry River district. It appears as an uncommon transient at York Factory (Preble, 1902: 87) and at Churchill and Cape

Churchill (Taverner and Sutton, 1934: 24). Blanchet (1930: 62) reports it at Tavane.

Melanitta deglandi (Bonaparte), White-winged Scoter.—On June 30 a male was satisfactorily observed on a tundra pond a mile northwest of the mouth of Windy River; it presently took wing. The species seems to have been previously unknown to the residents in the Nueltin Lake region.

There are a number of records from Churchill and Cape Churchill (Taverner and Sutton, 1934: 24), and one near Eskimo Point (Sutton, 1931: 157). Westward and northwestward it has been found on Athabaska, Great Slave, Great Bear, and Artillery Lakes and Anderson River (Preble, 1908: 294), and on Sifton Lake and Hanbury and Thelon Rivers (Clarke, 1940: 44); southward, on Reindeer Lake and Reindeer River (Buchanan, 1920: 230).

Melanitta perspicillata (Linnaeus), Surf Socter.—During (or just after) the breeding season Charles Schweder has observed only flocks of male Surf Scoters on Nueltin Lake—no females or young. This situation seems to parallel the one on Lake Athabaska, where flocks (presumably of males) may be seen moving westward in late June, probably on their way to salt water (Harper, MS). In September, 1946, Charles noted a few Surf Scoters on the upper Kazan River.

A previous record for Keewatin is that of Preble (1902: 88), south of Eskimo Point; the species also occurs at Churchill (Preble, 1902: 88; Tavernear and Sutton, 1934: 24). Southward it has been found in the Reindeer Lake region (Buchanan, 1920: 231) and at Sandhill Lake (Manning, 1948: 10); westward and northwestward, at Athabaska, Great Slave, and Great Bear Lakes, Anderson River, and Franklin Bay (Preble, 1908: 295), on the Tazin River (Harper, MS), and at Fort Enterprise (Clarke, 1940: 44).

It would be particularly interesting to ascertain whether the Atlantic-wintering and the Pacific-wintering populations of this species maintain more or less distinct breeding areas. There is a similar problem in the case of various other ducks breeding between Hudson Bay and Alaska. The solution will evidently depend upon banding operations.

Oidemia nigra americana Swainson, American Scoter.—On June 15, the day after the "break-up" on Windy River, a flock of three American Scoters passed downstream, low over the water. When the same or another flock of three males returned upstream half an hour later, their orange bills showed finely in the sun. On June 17 a single bird was seen on a nearby tundra pond. In former years Charles Schweder hunted this species on some sand ponds northwest of Red River Falls. In September, 1946, he noted numbers on the upper Kazan River; he considers it one of the commonest ducks there.

To the eastward the American Scoter has been recorded at Churchill (Preble, 1902: 88; Taverner and Sutton, 1934: 24), near Eskimo Point (Sutton, 1932: 76), and at Boulder Lake (Manning, 1948: 10). In the entire Athabaska-Mackenzie region there appear to be merely a few records from Great Slave Lake (Clarke, 1940: 46). This state of affairs suggests the possibility of an almost complete separation between the Atlantic and the Pacific populations of the species. In the light of our meager present knowl-

edge, it seems rather futile to even speculate on the location of the breeding grounds of the "large numbers" that migrate in the spring by way of the Kenogami and Albany Rivers in Ontario (Hanson, Rogers, and Rogers, 1949: 196).

Lophodytes cucullatus (Linnaeus), Hooded Merganser.—On July 23 Fred Schweder, Jr., secured an eclipse male on Four-hill Creek. In the plumage of head and body it resembles the adult female, but the crest is extremely small (not sufficient to show any lighter-colored tip); the wing coverts in general as in the female; the median coverts fuscous, instead of light gray as in the winter male; primaries, secondaries, and tertials Fuscous to Fuscous-Black (darker than in female); secondaries and tertials exhibiting more wear than the primaries; tertials shorter than in the winter male, the inner ones lacking a median white stripe; speculum as in winter male, but with the anterior white bar much reduced; rectrices much worn; maxilla dusky olive, brownish yellow at lower base; mandible brownish yellow; iris light olive; tarsus and toes olive; webs fuscous; testes elongate, 6.5 × 1.5 mm.; weight, 588 g. The alimentary canal contained fragments of aquatic insects and about two entire aquatic Hemiptera (?).

The rarity of specimens in the eclipse plumage may be judged from a remark by Phillips (1926, 4: 242): "Not examined."

There are a few records of the Hooded Merganser from Churchill and vicinity (Preble, 1902: 82; Taverner and Sutton, 1934: 25) and from Nelson River (Preble, 1902: 82); also from Great Slave and Reindeer Lakes (Preble, 1908: 277) and from the Athabaska Delta (Phillips, 1926, 4: 241). There is perhaps no previous record from Keewatin. The "northern Manitoba," quoted by Hanson, Rogers, and Rogers (1949: 195) from Macoun and Macoun (1909), obviously refers only to the old Manitoba whose northern boundary crossed Lake Winnipeg, since the statement was originally made by John Macoun (1900: 74) before Manitoba was expanded.

Mergus merganser americanus Cassin, American Merganser.—In the Nueltin Lake region this species appears considerably less common than the Red-breasted Merganser; my records for the season covered about 26 individuals. On June 17 a male, probably of this rather than the next species, was observed on an ice cake in Windy Bay. On June 20 the spattering of water with wings drew my attention to two males getting under way on Windy River. The next day a pair dropped into a quiet stretch of water on the river and began peering into the water with the fore part of their heads submerged. Then they commenced diving, and remained out of sight for a surprisingly long time (possibly nearly a minute). A male was seen on Windy Bay on July 10, and what was apparently a molting male of this species on Josie's Bay on the 18th; the latter, at sight of me, skittered over the water for a considerable distance, as if unable to take wing. On July 19 a flock of six males on Windy Bay managed, after some skittering, to rise into the air.

On July 22 a group of two males and a female presented a fine spectacle at their fishing in Windy River—peering beneath the surface, diving, and rearing on their hind quarters to flap their wings. The males, in eclipse plumage, had a general spotted appearance, with brownish-black heads. On

August 18 two eclipse males were taken from a gill-net close to the bottom in about 40 feet of water in Windy Bay. One of them was preserved; and the colors of its bare parts (noted on the 19th) were: culmen and nail dusky; rest of bill pale reddish; iris dark brown?; tarsus and toes orange-red; webs light brown. It was somewhat fat, and its weight (with saturated plumage) was approximately 3¾ lbs. The white portion of the upper surface of the wing (as well as the under side of the body) was suffused with yellowish. Its proventriculus contained about seven Nine-spined Sticklebacks (*Pungitius pungitius*), the largest about 53 mm. in length.

On September 7 a group of three Mergansers, perhaps of this species, was seen at the mouth of Windy River. On the 10th two immature birds were brought in from the gill-net in the above-mentioned location in Windy Bay. In one of them, but not the other, the whole ventral surface of the body was suffused with yellowish. Charles Schweder reported some of this species on the upper Kazan River in September, 1946.

Records of the American Merganser near the western side of Hudson Bay are few: Hayes River above York Factory (Preble, 1902: 82) and Churchill (Grinnell and Palmer, 1941: 48). Buchanan (1920: 226) found the species at Reindeer Lake. Westward and northwestward it has been recorded on Athabaska and Great Slave Lakes (Preble, 1908: 275), in the Tazin-Taltson River area (Harper, 1915: 161), and on the Hanbury and Thelon Rivers (Clarke, 1940: 46).

Mergus serrator serrator Linnaeus, Red-breasted Merganser.—On several occasions, from June 11 to July 2, either a pair or a male of this species were seen about the mouth of Windy River, generally in flight. On the 15th a pair were secured in Duck Bay by Fred Schweder, Jr., and the female was preserved; maxilla fuscous above; nail lighter; mandible and sides of maxilla dull reddish; iris pale red; tarsus and toes salmon red on inside, dull reddish on outside. The largest egg in the ovary was 25 mm. in diameter. The specimen was extremely fat and weighed approximately 1⅞ lbs. Its stomach and proventriculus contained only insect remains, as if the local scarcity of small fishes forced the Mergansers to such fare.

One June 21 a pair of Red-breasted Mergansers settled on Windy River near the female of a pair of American Mergansers. Soon another male joined them, and the two Red-breasted males began chasing each other, until presently all three birds of this species flew off. On July 19 an adult was seen on Windy Bay. On August 21 a female was taken from a gill-net set in about 40 feet of water in this bay. On previous occasions Fred Schweder, Jr., had found four Red-breasted Mergansers in his nets. On this day he reported a brood of 14 downy Red-breasted Mergansers with their mother at the mouth of Windy River.

On August 28 an adult female, accompanied by three half-grown young ones, was seen at the mouth of Little River. On the 30th a similar family party, but this time with eight or nine youngsters, was encountered in the same locality. The old bird, in marshaling her brood along the river's shallow margin, regarded me warily, as I sat quietly a couple of rods away; but the youngsters went about their affairs in blissful disregard of danger. They were thrusting the fore parts of their heads beneath the surface to look for

prey, and swimming right along in this attitude (*cf.* Swarth, 1911: 39; Townsend, in Bent, 1923: 19). Occasionally one would dash forward and partly under the surface in pursuit of something that might have been a young Grayling. On September 3 possibly the same family, with nine young ones, engaged in fishing in Windy River by our camp. Now even the watchful mother occasionally swam along with submerged head, like the others. As on the previous occasion, one of the group would now and then splash ahead with all speed in pursuit of prey; this time the bodies remained on the surface while the head disappeared in the element beneath. It was a pretty and spirited scene. On September 11 an adult with six young ones was seen off the river's mouth. On September 23 an alert adult, with three practically grown young ones, appeared in Windy River, where they fished in the usual style. On September 25 a flock of 11 was observed in the same vicinity, two among them appearing larger than the rest. On the same day three immature specimens were brought from the gill-net in Windy Bay; in at least two of these the ventral surface was distinctly yellowish.

During the whole season I found no evidence whatever that the adult male takes any share or interest in helping to care for the young broods, as reported by Townsend (in Bent, 1923: 16). Experience with fairly numerous broods of both species of large Mergansers in the Athabaska region in 1914 and 1920 was likewise negative on this point. It is true that once (July 23, 1914) on the Tazin River I found a male American Merganser (not in full plumage) in the vicinity of, rather than in attendance upon, a brood of 10 very small young ones with their mother. On the approach of my canoe, the male flew off, leaving the care of the downies entirely to the competent female parent. Phillips (1926, 4: 293) considers Townsend "certainly wrong" in crediting the male Red-breasted Merganser with caring for the young.

Charles Schweder reported this species breeding in former years at some sand ponds northwest of Red River Falls. He saw three birds on October 16 on Windy River below Simons' Lake; also some numbers on the upper Kazan River in September of the previous year. When Windy Bay became finally frozen on November 1, a Red-breasted Merganser appeared in the still open water of the river just above its mouth. It may have been wing-injured, for it would not flush when I waved and shouted at it from a distance of 75 feet. It was probably an immature male, with a distinct crest, a crown becoming dark, comparatively little white in the wing, and no sharp line of demarcation on the neck. The individuals recorded during the season numbered about 86.

With a breeding range extending somewhat farther north than that of the American Merganser, this species has furnished a considerably larger number of records in northern Canada, including the following: Melville Peninsula (Hørring, 1937: 20); Eskimo Point (Sutton, 1932: 79; Hørring, 1937: 20) and 50 miles to the southward (Preble, 1902: 82); (lower) Kazan River and Yathkyed Lake (Porsild, in Clarke, 1940: 46); Chesterfield area (Bray, 1943: 514); Churchill and Cape Churchill (Taverner and Sutton, 1934: 25); Sandhill, Boundary, Malaher, Boulder, and South Henik Lakes and Tha-anne River (Manning, 1948: 10); Reindeer Lake and Cochrane River (Buchanan, 1920: 226); Great Slave, Great Bear, and Clinton-Colden Lakes and Fort Anderson (Preble, 1908: 276); Artillery and Ptarmigan

(Casba) Lakes (Preble, 1911: 364); and Hanbury and Thelon Rivers (Critchell-Bullock, 1931: 13; Clarke, 1940: 46).

Accipiter gentilis atricapillus (Wilson), Eastern Goshawk.—Fred Schweder, Jr., reported seeing two Goshawks along Windy River on October 13; he also spoke of seeing one or two per year in previous years, chiefly in October. On October 22 Charles Schweder observed one in pursuit of two (Willow?) Ptarmigan along this river 3 miles above its mouth. The latter had apparently risen out of some spruce timber and reached a height of about 100 feet in the air, where they were above their pursuer. The Goshawk then desisted, and came to perch on a tree about 60 feet from Charles' camp, where he shot it. It proved to be an immature female: bill fuscous, basally plumbeous; cere and commissure pale lemon yellow; iris cream-colored; tarsus and toes pale lemon yellow; nails black; ovary 15×3 mm. The specimen was very fat, weighing approximately 2½ lbs. It had doubtless been living on Ptarmigan, since the border of the Barren Grounds at this season furnished extremely little else in the way of food birds. Its stomach contents were merely a few leaves and terminal twigs, evidently derived from the crop or stomach of some Ptarmigan.

On October 31 I was the appreciative spectator of a lengthy and lively game of tag between a hawk (apparently an immature Goshawk) and two or three Ravens in the air above one of the ridges in the Barrens near camp. The hawk was the principal aggressor, but now and then a Raven would take its turn in going after the hawk. The game was played for the most part at an altitude of, say, 40 feet. Once, however, the hawk glided so low in following a Raven that it barely skimmed the ridge. In general, it would maintain its pursuit until the other bird was almost overtaken. The Raven would then turn, and I believe both parties would make feints at each other while gyrating about. Apparently neither side in the game was at all in earnest in coming to actual grips with the opponent. Once or twice the hawk perched on the ridge, on either a rock or a small tree or bush. While the Ravens gave plenty of croaks, I heard no sound from the other species. A shot from my gun did not even cause it to desist from the game. It seemed worthy of note that in the grim, wintry Barrens some of the birds were not lacking in moments of playfulness. The incident is reminiscent of a battle between Gyrfalcons and Ravens in Greenland, as described by Manniche (1910: 186-187). Tuttle (in Bent, 1947: 194) writes of an encounter between a young Goshawk and a Raven.

Though skirting the edge of the Barren Grounds, the Goshawk does not seem, in general, to advance appreciably beyond the tree limit. To the eastward it has been recorded at Churchill (Preble, 1902: 106; Taverner and Sutton, 1934: 26); to the westward, at Great Slave and Great Bear Lakes and Anderson River (Preble, 1908: 353), and on the Athabaska and Slave Rivers (Preble, 1911: 376).

Buteo lagopus sancti-johannis (Gmelin), American Rough-legged Hawk.—The Roughleg was observed in small numbers but at fairly frequent intervals from June 2 to July 21, and from September 3 to October 22. I noted no more than three or four per day, and more usually, only one. The great

majority of the birds appeared to be in the light or normal phase of plumage. Some were seen in more or less direct flight, passing from one part of the area to another at a moderate height, but others would circle or occasionally hover. They were wary enough not to allow me to come within range once, I believe, during the entire season. One that was passing up the Windy River on September 16, with a brisk north wind, sailed for the most part, in practically any direction; now and then it would make a minor adjustment with its wings, but hardly give a real flap. It was unusual to see one except on the wing. On September 16 Fred Schweder, Jr., reported one flying up from a caribou carcass and alighting in a near-by tree. Three days later I flushed one from such a carcass. On October 4 Fred reported seeing about 30 Roughlegs, but part of these may have represented repeated observations of the same individuals. Twice (June 26 and September 16) I heard a distant cry that I was inclined to attribute to this species; it was somewhat reminiscent of a Redshoulder's or a Redtail's cry, or perhaps of a tern's, as Freuchen (in Hørring, 1937: 98) suggests. On July 19, at Josie's Bay, I saw some small bird following a Roughleg belligerently, but it was at such a distance that identification was impossible. On October 14 one of these hawks was seen along Windy River 4 miles above its mouth, and one at Simon's Lake. Approximately 80 individuals were recorded during the season.

In September and October the numbers of Roughlegs could probably be accounted for in part by the caribou bodies lying here and there in the Barrens. Ravens and Herring Gulls were likewise partaking of these free feasts. Charles Schweder credits the Roughlegs with ability to tear right through the hide of a Caribou.

He reported nesting sites in former years as follows: Hawk Cliff, about 300 feet above Windy Bay, where he found two well-grown young ones and an addled egg on July 9, 1944; a cliff on Nueltin Lake 4 or 5 miles north of The Narrows (where Cliff Swallows also breed); and a cliff on Windy Lake, where he found three young and an addled egg about 1943. He once saw a dead Ptarmigan at the nest on Windy Bay.

Sutton (1932: 80) records the Roughleg on Southampton Island and at Cape Fullerton; Hørring (1937: 97), from Queen Maud Gulf and Melville Peninsula south to Baker Lake, (lower) Kazan River, and Eskimo Point; Gavin (1947: 200), in the Perry River district; Manning (1948: 12), at Christopher Island, Keewatin. There are various records from Churchill (Preble, 1902: 106; Taverner and Sutton, 1934: 26). Westward and northwestward, the localities on record include Athabaska, Great Slave, and Great Bear Lakes and Anderson River (Preble, 1908: 357); Clinton-Colden, Aylmer, and Artillery Lakes (Preble, 1911: 377); Lac de Gras (Blanchet, 1925: 53); and Hanbury River (Critchell-Bullock, 1931: 16; Clarke, 1940: 46). Although the A. O. U. *Check-list* (1931: 69) states that the species "breeds chiefly in the Hudsonian Zone," I am much inclined to consider it more common on the Barren Grounds.

Aquila chrysaëtos canadensis (Linnaeus), American Golden Eagle.—Charles Schweder reports seeing this species almost every year between Nueltin and Reindeer Lakes; also noting a nest on a large jack pine on the Cochrane River 40 miles north of Brochet.

At the north end of Nueltin Lake the limited numbers of breeding waterfowl, the extreme scarcity of Snowshoe Rabbits, the summer absence of Arctic Hares, the total lack of Parry's Ground Squirrels, and the absence of Caribou fawns till August—all these factors might well deter the Golden Eagle from attempting to breed in the region.

To the eastward it has been found 30 miles inland from Eskimo Point and not far south of Churchill (Taverner and Sutton, 1934: 27); to the northward, at Kent Peninsula (Hørring, 1937: 96) and Repulse Bay (Snyder, 1949: 39); to the westward and northwestward, at Great Slave and Great Bear Lakes, Fond-du-Lac (Stone), Anderson, and Horton Rivers, and Cape Bathurst (Preble, 1908: 358); Muskox and Clinton-Colden Lakes (Preble, 1911: 377), Tazin River (Harper, MS), and Nonacho and Artillery Lakes (Clarke, 1940: 47); to the southward, between Norway House and Oxford House (Preble, 1902: 107).

Haliaeetus leucocephalus washingtonii (Audubon), Northern Bald Eagle.—Charles Schweder reported an immature Bald Eagle along Windy River between Nueltin and Simons' Lakes in June, and another on October 14. These are the only ones he has noted so far north, although he sees a few every year between the south end of Nueltin Lake and Reindeer Lake.

Apparently this species ranges very little beyond the tree limit. On the west side of Hudson Bay it has been found as far north as Churchill (Preble, 1902: 107). Southward it is reported by Buchanan (1920: 240) at Reindeer Lake and Cochrane River, and by Manning (1948: 12) at Eyrie Lake. In the Athabaska-Mackenzie region there are records from Athabaska, Anderson, and Lockhart Rivers and Great Slave and Great Bear Lakes (Preble, 1908: 360), and from the Tazin-Taltson River area (Harper, 1915: 161).

Circus cyaneus hudsonius (Linné), Marsh Hawk.—Only two individuals came under my observation at the mouth of Windy River, August 19 and September 2. The latter, a very dark and probably immature bird, flew up from a bit of meadow and circled about me within 20 feet or so, meanwhile giving a low call: *qui-qui-qui-qui-qui*. Then it alighted on the tip of a 15-foot spruce. Later it flew up again from that general area, and again alighted on a spruce tip. My dates correspond closely with those given by Taverner and Sutton (1934: 27) for augmented numbers at Churchill, indicating a migratory movement at that period.

On the west side of Hudson Bay the Marsh Hawk is known as far north as Churchill (Preble, 1902: 105). South of Nueltin Lake it has been found on the Cochrane River (Buchanan, 1920: 239). Westward and northwestward, there are records from Athabaska, Great Slave, and Great Bear Lakes and Anderson River (Preble, 1908: 351), and from Artillery and MacKay Lakes (Blanchet, 1925: 53). Evidently the species does not ordinarily venture to an appreciable distance beyond the tree limit.

Falco rusticolus obsoletus Gmelin, American Gyrfalcon.—On November 20 a flock of a dozen Rock Ptarmigan on the south side of Windy River gave their rolling note and in a few moments came hurtling across the river past our camp. They had probably been alarmed by a bird of prey noted there just previously by my young companion, Michael Schweder. A few minutes later two falcons appeared circling over the river. In size, shape, and general

color (including apparently a dark malar area) they looked very much like Duck Hawks, and I so recorded them at the time, though I marveled at the lateness of the date. The latest recorded date of fall departure of that species in northwestern Canada seems to be October 6 (Lincoln, in Bent, 1938: 66). Subsequent reflection has fairly convinced me that these two birds must have been Gyrfalcons, which would naturally have been interested in the Ptarmigan as their main winter fare.

Gyrfalcons from Arctic America generally (except Alaska) are now referred to a single subspecies by Todd and Friedmann (1947). Eastward, they have been recorded from Churchill (Preble, 1902: 107; Taverner and Sutton, 1934: 28); northward, from Banks Island, Victoria Harbor, and Felix Harbor (Preble, 1908: 361), Southampton Island (Sutton, 1932: 82), Melville Peninsula region (Cottam, 1936: 168; Hørring, 1937: 101), lower Kazan River (Porsild, in Clarke, 1940: 47), Bellot Strait (Shortt and Peters, 1942: 342), Admiralty Inlet (Bray, 1943: 515), Franklin Bay, Cape Bathurst, Bernard Harbour, and Coronation Gulf (Todd and Friedmann, 1947: 148), and Chesterfield (Porsild, in Manning, 1948: 12); westward and northwestward, from Great Bear and Point Lakes and Anderson River (Preble, 1908: 361), and Ptarmigan (Casba) River (Critchell-Bullock, 1931: 16).

Falco peregrinus anatum Bonaparte, Duck Hawk.—Single birds were seen at Churchill on May 26 and 29, the first circling near the grain elevator and the second perching on a stone monument at the mouth of the river. On August 20 a falcon, apparently of this species, flew up from a ridge near the mouth of Windy River.

The Duck Hawk has been recorded to the eastward and northeastward at Churchill, below Eskimo Point, and at Marble Island (Preble, 1902: 107), Southampton Island, Fullerton, and Chesterfield (Sutton, 1932: 84), and Carr Lake, Keewatin (Manning, 1948: 12); to the northward, at Melville Peninsula, Wager Inlet, Depot Island, and various other points (Hørring, 1937: 99), Somerset Island and Arctic Bay (Shortt and Peters, 1942: 342), and numerous places along the route from Hanbury River to Baker Lake (Clarke, 1940: 47); to the westward and northwestward, at Athabaska, Great Slave, and Great Bear Lakes and Lockhart River (Preble, 1908: 361), and Artillery, Clinton-Colden, and Aylmer Lakes (Preble, 1911: 378); and to the southward, at Fort Hall Lake (Downes, 1943: 149).

Falco columbarius columbarius Linnaeus, Eastern Pigeon Hawk.—On May 29 a Pigeon Hawk made an unsuccessful stoop at a flock of Snow Buntings along the river's edge at Churchill (see account of the latter species). The following day one of these falcons made an attempt to capture some small bird near the railway station at Churchill, but evidently missed it. On September 12 a Pigeon Hawk passed our camp on the Windy River; and a small bird of prey, probably of this species, was seen swooping at three Ravens. The Pigeon Hawk is known to pursue various birds larger than itself, including the Crow (Bent, 1938: 79).

To the eastward this species has been recorded at Churchill (Preble, 1902: 108; Taverner and Sutton, 1934: 29); to the southward, at Reindeer Lake and Lac du Brochet (Buchanan, 1920: 241); to the westward and north-

westward, on the Slave and Anderson Rivers and at Great Slave and Great Bear Lakes (Preble, 1908: 363), and at Ptarmigan and Artillery Lakes (Clarke, 1940: 48). The last author also mentions sight records by Porsild on the (lower) Kazan River and at Baker Lake. Gavin (1947: 201) reports Pigeon Hawks nesting commonly on cliffs in the Perry River district on the Arctic coast. The records from Mackenzie are presumably referable to *F. c. bendirei* Swann, provided that subspecies is recognizable (*cf.* Bent, 1938: 89).

Canachites canadensis canadensis (Linnaeus), Hudsonian Spruce Grouse. —Since the Spruce Partridge depends on timber growth for cover and for much of its food, it is scarcely surprising that its numbers are rather limited in the Windy River area, where probably 80 to 90 percent of the terrain is occupied by Barren Grounds. It is locally called "Spruce Hen" or "Black Chicken," the latter term apparently referring to the plumage rather than to the dark meat.

At Josie's Bay, in July, the droppings, composed largely of spruce needles and thus readily distinguished from those of Ptarmigan, were noted commonly in the spruce tracts, and on the 18th I secured an imperfect glimpse of a bird flushing from high up in a tree. In the extensive spruce tract along Four-hill Creek the droppings were found in August, but none of the birds could be located.

On September 12 Fred Schweder, Jr., secured an adult female together with four nearly grown young ones (a male and three females) among spruce timber on the Windy Hills. No ectoparasites were found on these specimens. Their bills were fuscous; base of mandible horn color; comb bright reddish (ad. female), dull orange-red (im. male), or pale orange-red (im. females); iris olive-brown (immature, both sexes); back of tarsus pale, dull orange (ad. female), dull yellowish (im. male), or dull greenish yellow (im. females); toes plumbeous; nails dusky; ovary 13×6 mm. (ad. female), 8×7, 11×6.5, and 14×7 (im. females); testes 3.5×1.5 (black); weight, 497.5 g. (ad. female), 340.2-356.6 g. (immatures). The bodies, converted into stew, made a very agreeable addition to our bill of fare.

The adult female has largely completed the postnuptial molt, except for the outer primaries, while some of the new throat feathers retain their basal sheaths. The three immature females, in their first winter plumage, closely resemble the adult, but their tails are not fully grown; their crowns are more buffy (Ochraceous-Tawny rather than Light Buff) and their throats are less buffy; the blackish spots on the throat are less distinct and less definitely arranged as bars; the whitish or pale buffy median stripe on the scapulars and coverts is much broader and more conspicuous; and the buffy bars across the scapular region are less clear-cut. The immature male is very similar to the immature females, but more heavily marked with black on throat and breast.

On September 27 I encountered a male in an upland spruce thicket; it took wing for a short distance, alighting on the ground, and on its next flight it disappeared over a ridge. Evidently it did not care to seek refuge in the small trees thereabouts. On October 6 Fred Schweder, Jr., noted a number of tracks in the snow among spruce tracts on the Windy Hills, and on the 12th I found fresh tracks among spruce and dwarf birch near our camp. These may be readily distinguished from the broad imprints made by

the feathered toes of Ptarmigan. Aside from tracks and droppings, eight individuals were recorded during the season.

Charles Schweder stated that after the families are reared, one encounters only solitary "Spruce Hens." In the Athabaska region, however, I have several times found from two to four or five birds consorting together in October (*cf.* Bent, 1932: 127).

For a strange instance of evident predation by Ravens, see the account of the latter species.

On the west side of Hudson Bay the Spruce Partridge is found as far north as the tree limit at Churchill (Preble, 1902: 102; Taverner and Sutton, 1934: 30). To the south of Nueltin Lake, it occurs at Reindeer Lake and Cochrane River (Buchanan, 1920: 236), between Kasmere and Nueltin Lakes (Downes, 1943: 163), and at Sandhill Lake (Manning, 1948: 12). In the Athabaska-Mackenzie region (where the subspecies *C. c. osgoodi* Bishop occurs) there are records from Athabaska, Great Slave, and Great Bear Lakes and near Fort Anderson (Preble, 1908: 337), and from Pike's Portage (Clarke, 1940: 48).

Bonasa umbellus (Linné) subsp., Ruffed Grouse.—Only negative information was secured concerning the Ruffed Grouse. Charles Schweder reported having noticed none of the birds on his numerous trips between Nueltin and Reindeer Lakes. The species is apparently unknown in the territory extending directly eastward to Hudson Bay, although Preble (1902: 103) mentions an old record of Dr. Robert Bell's from York Factory. To the southward, Buchanan (1920: 237) reports a few birds in the Reindeer Lake region. The northernmost localities indicated by Snyder and Shortt (1946: 122, fig. 1) for the subspecies *umbelloides* in Manitoba are The Pas and the upper Nelson River.

The subspecies of the Athabaska-Mackenzie region is considered *B. u. yukonensis* Grinnell by Friedmann (1946: 182), who remarks that it is "primarily a Hudsonian Zone form," though ranging south through the Canadian Zone as far as Fort McMurray. In this region there is a marked scarcity of records east of the Athabaska and Slave Rivers and in the Hudsonian Zone. There is an old record from Fort Rae (Preble, 1908: 342) and a more recent one from Reliance (Clarke, 1940: 48). The latter locality is not in the Thelon Game Sanctuary, as indicated by Friedmann (1946: 186). The experience of both Preble (1908) and myself in the Mackenzie Basin seems to indicate that the occurrence of the Ruffed Grouse in the Hudsonian Zone is exceptional.

Lagopus lagopus albus (Gmelin), Keewatin Willow Ptarmigan.—The Willow Ptarmigan is doubtless the most important as well as the most numerous game bird of the Nueltin Lake region. Here my records of individuals total about 1,757. The great majority of these were comprised in the migratory flocks of October and November, when probably very few duplicate counts were made.

In this region both species of Ptarmigan go by the simple name of "Chicken." The Chipewyan name for the present species is *Kasba;* the

Padleimiut name (on the Kazan River), *Aka-dyuk*. Whether these people have a separate name for the Rock Ptarmigan, I do not know.

Local status: While the Willow Ptarmigan is common here as a summer resident, it occurs in far greater numbers as a bird of passage in spring and autumn. Its status in winter is somewhat uncertain, owing to the probability of confusion with female Rock Ptarmigan; but I strongly suspect that a very large proportion (perhaps a majority) of the species spends this season in the wooded country to the southward (Hudsonian and upper Canadian Zones). Its breeding range evidently extends far northward in Keewatin and probably becomes contiguous with that of *L. l. leucopterus* somewhere north of Chesterfield Inlet and Baker Lake. Hørring (1937: 26) records intermediate specimens taken at Repulse Bay in December.

In traveling northward on the Hudson Bay Railway on May 21, I noted four Willow Ptarmigan at several points in the vicinity of McClintock (Miles 437, 439, and 448). These localities are near the southern border of a sizable tundralike area, where the birds may have been established for the summer, although the northward migration (or at least occurrence in flocks) continued as late as June 3 in the Windy River area. The males were conspicuous with their rusty-colored heads and necks, while retaining on their bodies the white winter plumage.

Spring migration: The period from May 31 to June 3 appeared to represent the final days of the spring migration about the mouth of Windy River. On the first-mentioned date about 100 birds (apparently all males), in a scattered flock, cackled as they burst into flight through the black spruces, alternately flapping and sailing. On the next day several flocks were seen flying in various directions about our camp. One such flock, of about 25 birds, was apparently composed entirely of males, although some females, with dark feathers appearing in the body plumage, were noticed in other flocks on the wing. The white bodies and wings of the males, when flying against a background of snowy landscape, all but disappeared, leaving only the dark heads and necks and perhaps the black tails clearly visible. The momentary impression created by such a flock was that it was composed merely of dark birds of sparrow size. On the other hand, when a flock would spring into flight against a background of green spruce timber, these birds of the snow afforded a remarkably fine and spirited spectacle. On June 2, and again on the 3rd, a flock of about a dozen birds was seen. These represented the last of the spring flocks; they were doubtless bound for summer homes on the Barrens to the northward. Before they passed on, these Ptarmigan flocks were the most conspicuous feature of the local bird life. Thereafter, for two or three weeks, the species was still conspicuous, though represented merely by pairs or single birds.

Activities of the breeding season: By June 1 the local birds were evidently established in their breeding territories. Whereas the migrant flocks had been fairly wild, these breeding birds were now remarkably confiding. During the morning of June 7, and again during the long evening, with the temperature close to freezing, a pair of Ptarmigan promenaded along the side of a ridge in the Barrens. The female either stood near the male or walked a few feet

in advance of him. The latter held his tail somewhat elevatd and spread, but his head rather low. The female uttered pretty steadily a somewhat higher-pitched note than the male's: *go-lick, go-lick, go-lick,* etc. From a considerable distance the vocal utterance of the male sounded somewhat like a long succession of guttural notes, emphasized now and then by a terminal cackle. Two days later, in the same area, this pair allowed a close approach on my part—the female within a rod. She twitched her tail up and down as I came nearer, and increased the tempo of the motion as she walked off over the snow. The male protested with his guttural cackle: *quek, quek, quek, quekrrrrrrrrrr!* As he did so, there was some inflation of the lower neck, but no exposure of the lateral bare areas, which are present in both sexes. Presently he flew off with rapid wing-beats, followed by a longish sail.

Marks of wings beside some tracks on June 7 seemed to indicate the occasional use of these appendages as auxiliary supports in soft snow.

On June 10 the croaking or cackling of a Ptarmigan drew my attention to a cock sailing over a sedge bog, pitching down steeply on set wings, and walking off over the snow. Presently it perched on a rock on an open hillock under a cloudless sky, and occasionally indulged in its cackle, which I now represented as *ko, ko, ko-ko-ko-korrrrrr!,* with a rising inflection at the end. After half an hour or so it flew off for a hundred yards. Toward the end of its flight it rose upward for a bit as it began to cackle, then pitched downward and alighted on snow at the edge of the bog, perhaps before the cackle was finished. Later in the day I found the cock once more on the rock on the hillock, and was about to photograph it at a distance of 20 to 25 feet, when it simply vanished noiselessly. Previously it had seemed to challenge me several times with an apparent variation of its earlier cackle, for I now wrote it down as *bek, bek, bek-bek-bek-kr-kr-kr-kr-kr-kr!* (Now and again several emphatic, peremptory notes were added to the cackle: *go-bek′, go-bek′, go-bek′.*) On the following day the cock was still cackling from its hillock, while the female was at the border of the bog and again exhibited the rapid vertical vibration of its tail. By this time the latter bird was predominantly brownish above.

No combats between rival males came under my observation (*cf.* Bent, 1932: 179). The birds were so sparsely distributed that there was little or no occasion for contests over breeding territory.

The Willow Ptarmigan's cackling, with accompanying flight exhibitions, will always be associated with my recollections of the border of the Barrens in the raw weather of early June. It constitutes a distinctive and predominant bird voice of that region and season; it contributes its full share to the atmosphere of "the land of Caribou and Ptarmigan."

There now set in a period when the Ptarmigan became much less conconspicuous and noisy. Presumably incubation was under way, and the birds, after having molted into summer plumage, were much less easily detected. On June 15 one or two birds were seen, and on the 17th the male of a pair ended its flight, as usual, with a cackle. Only three individuals were recorded during the remainder of June; a marked change in the behavior of the cocks, at least, had obviously taken place. On the 26th not one Ptarmigan was found in a walk of about 5 miles over the Barrens, although the breeding

population probably averaged at least one pair to the square mile. During the greater part of July, likewise, the birds seemed to have dropped out of sight. On the 12th I flushed a female at Josie's Bay, and on the 20th the two younger boys of our camp brought in another female with a chick.

On July 27 I had an interesting adventure with two adults and a chick on a ridge in the Barrens. I first became aware of their presence when the adults began scuttling over the ground almost at my feet, their wings outspread and the white ends showing very conspicuously. Meanwhile the chick took wing afar, flying high and fast—a curious spectacle for such a mite. I started in pursuit of the old birds with an insect net, and I believe I touched one. The larger male, with a rusty neck, was the bolder of the two, the female holding more aloof. When I desisted from the chase, they returned toward me, and stood some 60 feet away. The female now called *kuk, kuk, kuk,* etc.—a note I had heard in the first moments of the encounter. The male possibly had the same note; but, if so, it uttered in addition a deeper, throatier *ow, ow.* In walking about nervously, one of them (probably the female) twitched its tail up and down rapidly. I suspect that this action (noted from early June to late November) is especially characteristic of the female and possibly limited to that sex.

On July 28, on the opposite side of Windy River, I came upon a female with half a dozen chicks just able to fly, and scattering rapidly. With self-sacrificing instinct, the mother threw herself in front of the intruder to distract attention from her offspring. The next day I encountered probably the same female (with similar behavior) and several chicks in a riverside thicket of willow and spruce. On the 30th I secured one of two chicks in the same area; in general, these youngsters were far more elusive than their parents.

On August 2 an adult on a hillock across the river from our camp called *gwar, gwar, gwar*—strangely suggestive of the flight note of the Pacific Loon, though far less loud and coarse. On the 7th Anoteelik secured a half-grown Willow Ptarmigan with a skilfully aimed stone. On August 13, when a female with about five half-grown young ones started to move across the camp area, three of the latter were secured. When the first one fell and lay fluttering, the mother made a pathetic spectacle by dashing to it, standing beside it, probably fluttering her own wings, and calling. One of the young birds had a bilberry (*Vaccinium uliginosum*) in its throat. On the 16th I encountered a pair of adults and about five or six half-grown young ones in a sedge bog; it was an easy matter to collect the male as it engaged in the usual self-sacrificing behavior.

Autumn and winter activities: Between August 16 and September 22 I observed no Ptarmigan. Even such keen hunters as Charles Schweder and Fred Schweder, Jr., saw exceedingly few during this period; apparently the birds had some special knack for keeping out of sight. On the last-mentioned date I heard from across the river a note like that of August 2; at first I took it for that of a loon, recording it as *gwar-gwar-gwar-gwar-gwar-gwar.* On the same day a flock of four was seen moving across a frozen sedge bog. One or two, with more rusty-colored necks than the others, were perhaps males. Thickly feathered tarsi and toes gave the birds a bottom-heavy look. When I started to follow them, they were at first inclined to "freeze," but soon began

to walk away, one of them (apparently a female) doing the tail-agitating act. Even when I walked rapidly after them and came within some 20 feet, they walked (or perhaps ran) ahead, and would flush only occasionally, flying merely a rod or two. One of them gave a low *gwar-gwar* note. When I desisted, a couple of them paused at a distance of 50 feet and began to feed. They seemed to be pecking at the seeds of a sedge (*Carex* sp.).

On September 27 apparently the same flock of four was encountered in the same bog. Their plumage had then become about half white and was very conspicuous against the brown sedges. As they alighted after a short flight, I heard once more a subdued *gwar* from them.

The local and temporary scarcity of the birds was indicated on September 24 by failure to find a single track in fresh snow during a walk of a couple of miles. On the following day, however, I secured three specimens from a flock of eight or ten in a thicket of spruce and dwarf birch near the river. These birds may have represented a family party; there was as yet no indication of flocks composed of more than one family. All three specimens had their crops crammed with crowberries (*Empetrum*).

On October 1 I collected two birds from a flock of about five in a spruce thicket. The usual low note (*gwar*) was heard from them. On the 8th one or two birds were seen, and numerous footprints appeared on the snow in an upland spruce thicket, where I had found few or no Ptarmigan for several months. Those now present very likely represented an initial incursion from the north—a movement that became very pronounced during the remainder of the month. I also heard on this day a cackle ending in several loud, challenging notes—*go-bek'*, *go-bek'*, *go-bek'*—such as had been heard in the spring but not during the summer. According to Charles Schweder, the birds resume this call when the snow comes in the autumn. He also reported seeing on October 8 the first of the southbound migrants—a group of three flying at a height of about 40 feet at the mouth of Windy River. On the next day he saw a flock of about 40 similarly engaged in the same locality.

On October 10, aside from finding numerous tracks, I flushed a flock of about a dozen Ptarmigan and another of half that size from ridges in the Barrens. I had been attracted to the first of these by an unfamiliar call—*kyoop, kyoop;* I found no other bird or mammal in the vicinity that might have uttered it. On the 12th Charles Schweder reported three separate flocks, of about 26, 40, and 20 birds, flying southward at a low height across the mouth of Windy River.

On the afternoon of October 13, as we were traveling several miles up Windy River, an extensive migration was under way. Perhaps ten or twelve flocks were seen, numbering from about a dozen to 60 individuals and averaging in the neighborhood of 40. The general direction of the movement was southward across the river. They traveled rapidly, alternately flapping and sailing. From one flock, passing directly overhead, the *whiff-whiff* of their wings was heard. Another flock just skimmed the edge of the 100-foot hills across the river, their white bodies gleaming against the bare ground. The more distant flocks did not appear so gleaming white, but rather grayish white. It was a novel and remarkable experience to observe members of the generally

sedentary grouse family engaged in prolonged migratory flight and traveling at such a height. Snyder and Shortt remark (1936: 4): "The movements of these birds on their winter wanderings [are] of particular interest, since actual flights have seldom been witnessed." Their extensive migrations naturally fit the Ptarmigan for more sustained flight than such relatives as the Ruffed Grouse and the Spruce Partridge.

From October 14 to 21 southbound flocks were noted nearly every day at Simons' Lake and vicinity. One flock, passing over the lake at a height of about 40 feet, alighted on a ridge beyond. On the 16th Charles Schweder, traveling up Windy River to Simons' Lake, noted about 400 birds, including 300 in one flock. Some flocks alighted on the bordering hills after crossing the river; others continued flying as long as they remained in sight. In general the flocks I observed appeared to be more or less spindle-shaped, several times as long as broad. In the late afternoon of the 20th several flocks, numbering approximately 60, 15, and 15, passed over Red River at the falls, about 3 miles above Simons' Lake. Perhaps they had used the prominent Hudson Bay Hill, on the north side of the river, as a vantage point from which to scan the country ahead and to set sail.

From October 24 to 30 several flocks and single birds and numerous tracks were noted about the mouth of Windy River. Two flocks, of about 25 birds each, were seen on the 24th and 25th; the first was in southward migratory flight. Tracks in a marsh beside the river showed that the birds had been picking at the terminal buds of low willows. In another place they had been feeding on a little patch of crowberries, from which they had removed the snow cover in some manner. At that period Ptarmigan tracks were the dominant evidences of animal life, adding a picturesque element to the wintry landscape. Just before two birds took wing at my approach, I heard the *gwar-gwar-gwar* note, which apparently serves as a warning or alarm. On the 28th I came upon the previous night's roosting-place of a Ptarmigan. It was an open hollow, looking much as if the crown of a derby hat had been pushed down 5 or 6 inches into the snow. At one end was an accumulation of droppings such as I had been noting all through the summer, as indications of the location of old roosting-places. This spot was on the lower slope of a slight ridge in the Barrens, just outside of a patch of timber.

On nearly half of the days in November I noted small numbers of Willow Ptarmigan or their tracks, but no large migrant flocks, such as had been passing in October. Evidently the main southward movement had taken place during that month. However, on November 7 Fred Schweder, Jr., returning to camp from 10 miles to the northward, reported seeing a good many Willow Ptarmigan flying southward with a snowstorm then in progress. On a trip to and from the upper Kazan River, November 7 to 22, Charles Schweder reported only a few Ptarmigan. On November 6 I noted a roosting-place in shallow snow beside spruces on a ridge in the Barrens; there was a collection of droppings in it, and more near by, with tracks that did not appear so close together as those of Rock Ptarmigan.

On November 7 a flock of four birds appeared in a growth of willow, dwarf birch, and grass at the border of the river in our camp area; they were

so little wary that all four were collected with two shots. Two were typical *L. l. albus;* another was an aberrant individual (apparently a hybrid between the Willow and the Rock Ptarmigan); and the fourth was *L. l. leucopterus.* All were males, and all were in their first winter, except for one adult *albus.* This was the only definite evidence I found, during the entire season, of the occurrence of more than one form of Ptarmigan in a single flock. This case, together with observations on a couple of apparently all-male flocks in late May and early June, furnishes a little evidence of sexual segregation in the winter and spring flocks of Ptarmigan. Porsild remarks (1943: 25) on the occurrence of flocks of male Willow Ptarmigan on the Mackenzie Delta during the winter. In the present instance, at least, the attraction between males of even different forms was apparently more potent than that normally existing in the non-breeding season between the two sexes of the same species.

After November 19 I collected no Willow Ptarmigan, and I saw none with the possible exception of two small flocks (of three and five birds) on November 30. In these I detected no definite black stripe through the eye, which would have distinguished the male Rock Ptarmigan. Furthermore, at least one of them indulged in the tail-agitating act; and this, as far as my own experience goes, is not practiced by the Rock Ptarmigan. (However, Sutton writes (1932: 97) of a female Rock Ptarmigan "flicking her tail quietly.") On a five-day trip from Windy River south to Putahow River and return, November 26 to 30, Fred Schweder, Jr., saw no Willow Ptarmigan. His experience confirmed my impression that comparatively few of this species remained in the local area at this season. The Rock Ptarmigan had become the predominant species after the middle of November. Owing, however, to the erratic nature of Ptarmigan movements, it would be difficult to say whether this is the normal state of affairs for the Nueltin Lake region.

Habitats: The Willow Ptarmigan manifests considerable liberality in its choice of habitats, ranging from spruce timber and thickets of willow or dwarf birch to sedge bogs, hilly Barrens, camp dooryards, or the frozen borders of rivers. If there is perhaps one habitat favored somewhat more than the others, it may be the dwarf birches on the slopes of ridges in the Barrens. This growth varies in height and density, but it furnishes good cover and food for the Ptarmigan, old and young. The spruce thickets may serve better as nocturnal retreats in winter than as feeding grounds. Although the birds seem to exhibit here a certain predilection for the borderland between forest and tundra, there is a vast extent of country in their summer range to the northward where they leave the forest behind. The desertion of the Barren Grounds in winter by a large proportion of the population suggests that this environment is a little too severe at that season to be thoroughly agreeable to them.

Bent states (1932: 185) that Willow Ptarmigan "alight readily on trees and bushes." However, I observed no tendency whatever to use trees as perches, and only once, in June, did I note a female standing in or on a clump of spruce, doubtless no more than knee-high.

Notes from residents: Out of his years of experience in this region, Charles Schweder contributed some interesting information on the Willow Ptarmigan. (Since it is difficult, not to say impossible, to distinguish at a distance indi-

viduals of this species from some Rock Ptarmigan, it must be borne in mind that his observations may apply in part to the latter species.) Flocks of six to eight birds seen during the latter part of summer doubtless constitute a family group, though the birds of the year may be so large as to be indistinguishable from the adults. When the migrants first come south in the fall, they do not, in Charles' opinion, congregate in large flocks, but simply become more numerous day by day. All through the winter one may now and then see flocks flying south, at altitudes up to 200 feet. These flights are considered an indication of storms to the northward. They are generally noted soon after the freeze-up, but depend to some extent on storms. (In the mild fall of 1947, when the freeze-up was delayed till November 1, the major flights were noted in October.) A hundred individuals is generally about the maximum number Charles sees in such flocks. (On May 31 I saw a flock whose numbers I estimated at 100; in October, several flocks of as many as 60 or 70 individuals.) The northbound flocks in the spring do not fly high; they merely feed along the ridges, and occasionally take wing for half a mile or so. The high-flying flocks in the fall are evidently traveling far.

Charles spoke of the capture of both species of Ptarmigan in winter by means of gill-nets stretched on the land, in places frequented by the birds for feeding, such as thickets of birch or willow. The nets are left somewhat loose, and the birds become entangled in them. They are generally still alive when found, if the nets are visited daily. The Chipewyans practice this method about the south end of Nueltin Lake, where many of the old nets may be seen hanging in bushes.

The flocks vary much in their wariness during the winter. Sometimes a flock will depart at the first shot. On the other hand, Charles and his father once secured 40 birds out of a flock of about 60, using large rifles; they did this to keep their dogs from starving. One of the rare hazards encountered by Ptarmigan in this region is a radio aerial stretched near a trapper's cabin. Occasionally, while sitting indoors, Charles will hear something strike the wire, and find that it is a Ptarmigan, perhaps having broken its wing in the encounter.

He sometimes hears the migrant flocks passing overhead at night—just their wing-beats in the quiet air, with no vocal sound. He does not recall hearing the birds give any call at all on their migratory flights.

The roosting habits in winter were described by Charles as follows. The Ptarmigan go to roost early, and also start the day early, as soon as it is light. They burrow into the snow when it is not too hard to penetrate. Some fly out of the Barrens to spend the night in the patches of timber, where the snow is apt to be softer, but others remain on the Barrens. He thinks their burrows are only 3 to 6 inches beneath the surface; thus they can easily tell when daylight comes. After entering the snow, they may, he thinks, progress a little distance beneath it before pausing for the night. If a person walks, or drives dogs, over the burrows at night, or before the birds depart in the morning, they may emerge one by one, or just a few at a time—not the whole flock. They then generally make only a short flight, just to get out of the way of the dogs; sometimes, however, they remain awing for a couple of hundred feet, or even more. When the birds emerge in the morning of

their own accord, the whole flock seems to do so at about the same time; they then walk away over the snow, rather than fly. They first go to some ridge and "gravel up"; then proceed to their feeding grounds. Some years previously, when living at the Old Post on Red River, Charles would throw out a shovelful of sand and gravel, where the "Chickens" would come in the morning for their gravel. From a blind of spruce trees near by, he would shoot the birds with a shotgun when they were closely assembled, sometimes securing 12 to 14 with one discharge. Even when shot at more or less daily, they would continue to come to the spot. That winter the inhabitants of the Old Post did not secure a sufficient number of Caribou or have a sufficient supply of fish, and felt obliged to eke out their dog feed with Ptarmigan, to the number of 1,200.

In May the birds are apt to approach a camp closely early in the morning and make a considerable racket. Charles has gotten up and thrown a frying-pan at them to chase them away. The noisy individuals are the cocks, the hens being comparatively quiet.

Once, in mid-May, on the Kazan River 20 miles below Ennadai Lake, Charles saw many Ptarmigan walking northward over the snowy ground. The "Chickens" covered the hills as far as he could see; they kept moving past a given spot for two hours. That day he traveled about 12 miles, and there were many in sight all along the way—all moving north. As long as they were undisturbed, they remained on the ground. There were flocks of at least 500, and all told there were thousands of birds. He believes that most or all of them were Willow Ptarmigan.

At another time, toward the end of May ("about the second thaw"), Charles witnessed a similar movement in the southern part of Nueltin Lake, both on the mainland and on the islands. He traveled south through the throng of birds for 15 miles. It was daylight when he reached The Narrows and they started moving north. They would fly from island to island in long, narrow flocks, instead of walking across the ice. He would encounter them when crossing points of land jutting into the lake; as his dog sleigh passed along, the birds would merely walk or run to one side, without taking wing. (Ordinarily, however, the spring flocks are rather wary.) The numbers he saw that day must have amounted to 4,000.

According to Charles, the winter food consists largely of the buds of willow and dwarf birch. To this diet Fred Schweder, Jr., added berries (doubtless chiefly *Vaccinium vitis-idaea* and *Empetrum*). The use of sedge (*Carex*) seeds has been mentioned above. A specimen taken on October 25 had its crop much distended with leaves that appeared to be those of *Andromeda polifolia*, together with some berries of *Vaccinium vitis-idaea* and a few of *Empetrum*. (No report is yet available on the contents of the crops and stomachs of other specimens.)

Charles reported Willow Ptarmigan in winter along the Little Dubawnt River, south of Dubawnt Lake, but in smaller numbers than along the Windy River.

Enemies: Birds of prey are evidently among the principal enemies of this species (see the accounts of *Accipiter gentilis atricapillus* and *Falco rusticolus obsoletus*). Fred Schweder, Jr., once saw some Ptarmigan in flight at an alti-

tude of about 400 feet, with an unidentified hawk in pursuit. It speaks well for the Ptarmigan's power of flight that it should attempt escape from a dashing raptor by towering above it. Charles Schweder spoke of finding bones of Ptarmigan about the dens of Red Foxes. I secured virtually no information concerning predation by other animals. The Kazan River Eskimos apparently use Ptarmigan to only a limited extent as food for themselves and their dogs, much preferring Caribou as long as they are available. (The specimens we collected made very acceptable table fare.)

Ectoparasites: Out of 22 specimens of *L. l. albus* collected, nine (of both sexes and all ages, June 1 to October 25) yielded the following Mallophaga: *Lagopoecus* sp. (on eight specimens) and *Gonoides lagopi* (on two specimens). An apparent hybrid (No. 1354, November 7) between the Willow and the Rock Ptarmigan yielded *Menopon striatum* and *Goniodes lagopi.*

Plumages: The specimens collected represent fairly well most of the plumage phases to be found from May to November.

Among six chicks, there is one (male, July 20; weight, 28.8 g.) that is still largely in the natal down. The wing feathers retain the basal sheaths, and none of them are white. Contour feathers are beginning to appear on the sides. The down is Straw Yellow on the throat, slightly buffier on the remaining under parts. The black-bordered Auburn patch remains on the crown and occiput. An older chick of July 30 (female; weight, 70.8 g.) has down persisting on the throat, middle of the breast, and the nape. The Auburn patch on crown and occiput is being replaced by contour feathers. The wing feathers are dusky, spotted or barred with buffy or whitish. No white primaries of the juvenal plumage have yet appeared. A later stage is represented by a female of August 7 (weight, 152.4 g.), which has lost most of its down except on the posterior abdomen. The crown patch has disappeared. Two outer primaries are developing as white feathers, with a dusky area and speckling near the tip of the second. The under parts are largely Light Ochraceous-Buff, barred with blackish. This stage of development evidently corresponds to that which Conover (in Bent, 1932: 182) found in Alaska on July 22, or more than two weeks earlier.

In two juvenile males of August 13 (weights, 210 and 169 g.) and in one juvenile female of the same date (186.1 g.), the two outermost primaries are white, the distal portion of the second with a narrow dusky area extending on each side of the shaft and with a slight dusky speckling. Two or three of the innermost primaries, that are now white, furnish evidence of the post-juvenal molt (*cf.* Dwight, 1900: 153). The feathers of the upper parts are black or Fuscous-Black, barred or edged with Ochraceous-Buff or whitish. The under parts are Light Buff on throat and mid-venter, elsewhere Ochraceous-Buff, barred or spotted with Fuscous-Black. (These three juveniles were noted as each having two intestinal caeca, about 380-400 mm. in length.)

A series of five birds (September 25 and October 1) exhibits the transition from first autumn to first winter plumage. They comprise two males and three females. Each seems to be a bird of the year, with an elongate spot near the tip of the second primary and with more or less speckling on this and (in some cases) the first primary. As shown by Dwight (1900: 153),

these two primaries are not molted at this time, being retained from the juvenal plumage. The growing third primary is shorter than the second. The three birds of September 25 retain, for the most part, the dark head, breast, and back of the autumn plumage, with only a few scattered white feathers, whereas in the two birds of October 1 these portions show a considerable admixture of white feathers.

Five birds, taken on October 19 and 25 and November 7 and 19, are in practically full winter plumage, although the October birds exhibit a few Auburn or blackish feathers on crown and throat, and one of November 7 retains a single Auburn feather on the breast. "In some cases brown feathers may persist through the long Arctic winter" (Dwight, 1900: 156). Two of the five specimens show spotting or speckling of one or both of the two outermost primaries and are presumably in their first year. In one of these subadult specimens (October 19) the third primary is shorter than the second, while in the other (November 19) it is longer; thus in first-year birds the third primary apparently begins to surpass the second primary in length in late October or early November (*cf.* Petrides, 1942: 315). "Young birds can be distinguished during their first winter by the outer primaries, which are more worn and often speckled at the tips" (Bent, 1932: 183); this statement, though contrary to one by Friedmann (1946: 98), is apparently correct.

Among three adult males of this period, one (No. 1349), of October 25, while evidently in at least its second year, shows one character generally confined to first-year birds—an elongate dusky spot at the tip of the second primary; it has the greatest wing length (205 mm.) and the second greatest weight (680.8 g.) in the entire series. Another (No. 1356), of November 7, is in its second or a later year; all its primaries are practically pure white except for the shaft streaks; it has the maximum weight (740.5 g.) and the second greatest wing length (201 mm.) in the entire series; and the made-up skin is obviously larger than any other. Still another (No. 1357), of November 7, though practically without any fine speckling on the primaries, has an elongate dusky spot on the third as well as on the second primary near the tip; but it has grooved claws (*cf.* Petrides, 1942: 315) and a third primary 10 mm. longer than the second, and so is considered to be in at least its second year.

One specimen (No. 1354, subadult male, November 7) presents such a baffling combination of the characters of the Willow Ptarmigan and the Rock Ptarmigan as to suggest the probability of its being a hybrid. On the one hand, it was in company with three *Lagopus lagopus* (two of the subspecies *albus*, one of the subspecies *leucopterus*), and all other Ptarmigan flocks encountered were composed, as far as I could determine, of a single species. The depth of its bill is 8.5 mm., compared with a maximum of 7.75 in my series of *L. mutus rupestris* and a range of 9 to 10.5 in the series of subadult and adult Willow Ptarmigan. It is like most of my specimens of the latter species in that the white upper tail-coverts extend farther (5 mm.) beyond the rectrices than the average (1.8 mm.) in *rupestris*. It has a densely speckled second primary, like that of a one-year-old female *albus* of June 1, whereas none of the specimens of *rupestris* show such extreme speckling. On the other hand, its weight (452 g.) is even less than that of any of the Rock Ptar-

migan, and its wing measurement (180 mm.) is even less than that of three subadult *rupestris*. Its outer primary covert is speckled—a character it shares with all three subadult *rupestris*, but with only one male and one female among seven autumn subadults of *albus* and with a one-year-old female of that form (*cf.* Petrides, 1942: 314). Further affinity with *rupestris* is suggested by the presence of some white-tipped black feathers about the base of the bill and behind the eye. In length of tarsus (approximately 32 mm.) it resembles *rupestris*. The made-up skin appears a trifle large for *rupestris*, but small for *albus*. In view of this mixture of characters, the specimen may be regarded as either a highly aberrant individual of *albus* or a hybrid between the Willow and the Rock Ptarmigan. Since Taverner (1932b) has described a hybrid between a Willow Ptarmigan and a Spruce Grouse, the hybridization here suggested would appear to be well within the bounds of possibility.

The first and second primaries of this specimen are worn and a little soiled, and each has an elongate dusky spot toward the tip. A few chestnut feathers remain from the autumn plumage—two on the crown and about ten on the throat. There are several white-tipped dusky feathers on the lower nape, two on the breast, and one on the belly. The testes were 5×2.5 mm. (not pigmented). The bill was black; base of mandible plumbeous horn color; comb dull vermilion; iris warm brown; nails brownish horn color. There was practically no rosy pink flush to the plumage.

From October 25 on, most of the other specimens collected were noted as having a faint rosy pink flush on the white plumage; in some cases this was more particularly evident on the back and on the under side of the wings. It had not wholly disappeared more than a year later.

The dress in which the male carries on its conspicuous nuptial activities in early June seems to represent a transitional or early phase of the summer plumage (or spring plumage, as termed by Bent, 1932: 183), and it is not generally described separately. It is so distinctive and characteristic, however, and appears at such an important period in the annual cycle of the species, that a few words may well be devoted to it. In a specimen of June 1 (in its third or later year) the white winter plumage remains except on the head and neck. The new feathers of these parts are between Chestnut and Auburn; they have blackish tips, narrower on the head, but becoming broader and giving a darker appearance around the base of the hind neck. A few worn white feathers of the winter plumage remain about the base of the bill, about the eyes, and on crown and nape. The primaries are wholly white except for the dark shafts.

In a female of June 1 the feathers of the summer plumage (blackish, with Ochraceous-Buff bars and tips) have begun to appear on head, neck, breast, and back. An age of nearly one year is indicated by a well-speckled second primary, with a dusky spot near the tip.

In an adult female of July 20 the primaries, though worn and soiled, are practically white except for the shaft streaks. There is a large bare brood-patch. The tarsi and toes are mostly covered with old feathers. The nails are in process of shedding; Conover (in Bent, 1932: 182) gives July 22 as a date for this phenomenon in Alaska.

Two adult males (August 16 and 20) are in autumn plumage. The pri-

maries are almost wholly white, except for the shaft streaks. Two to three of the outermost primaries are much worn; the rest are new. Comparatively little feathering remains on the tarsi and toes. The nails are short, presumably after recent shedding.

Measurements: The wings of six adult males (June 1 to November 7) are 194-205 (198.1); and of three males in their first autumn (September 25 to November 19), 184-193 (189.3). The wing of an adult female (June 1) is 190; the wings of four females in their first autumn (September 25 to October 19) are 178-184 (181.5). It is thus evident that birds in their first autumn have, in general, shorter wings than older birds. (An adult female of July 20, with a wing of only 179, is left out of consideration, owing to the worn state of its plumage.)

Weights: The weights of six adult males (May 31 to November 7) are 551-740.5 g. (631.3); of three males in their first autumn (September 25 to November 19), 518.4-668.3 (591.4); of one adult female (June 1), 537; of four females in their first autumn (September 25 to October 19), 508.1-586.2 (542.6). The natural tendency toward greater weight in the older birds is somewhat obscured by the reduced weights of two males (551 and 556 g.) and a female (537 g.) of May 31 and June 1; this condition may have been due in part to the excitement of the nuptial season, and in part to the limited food available just prior to the summer's abundance. The crop of one of these males was only partly filled, and that of the female was practically empty, whereas at other seasons the crops were generally distended with food material. Anderson states (1913: 477) that 15 Willow Ptarmigan in October weighed 22 lbs. —an average of approximately 652 grams. Dixon (1927: 216) gives the average weight of male Alaska Willow Ptarmigan in the breeding season as 507 grams—which is somewhat less than that of my Keewatin specimens. An adult female of July 20 was not fat; other specimens, including both sexes and subadults as well as adults (August 16 to November 7), varied from slightly fat to rather fat. In winter, according to Charles Schweder, the birds remain fairly "poor" (*i. e.*, lean).

Gonads: The testes of adult males measured as follows: May 31, 12× 8 mm.; June 1, 11×7; August 16, 5×4; August 20, 5.5×2.5; October 25, 5×2; November 7, 5×3 (two specimens). Those of males in their first year: July 20, smaller than pinheads; August 13, 3×1.5 and 3.5×2; September 25, 5.5×3.5; October 1, 5×3; November 19, 6×2.75. Thus in October and November there is no appreciable difference in the size of testes between birds in their first autumn and those a year or more older. Of two adult males of November 7, the testes were pigmented in one, scarcely pigmented in the other; in a bird in its first autumn (November 19), not pigmented. A female of June 1 had an enlarged ovary, but evidently had not begun oviposition; one of October 19, in its first autumn, had an ovary 11×10 mm.

Bare parts: Colors of the bare parts in eight adult and subadult males (May 31 to November 7) were recorded as follows: bill black or fuscous, in some cases with the tip of the maxilla paler and with the base of the mandible horn color or plumbeous; comb vermilion (bright in one adult of October 25); iris olive-brown or warm brown; nails varying from blackish basally,

horn color distally, to horn color, in some cases with brownish tip or dusky base. Six adult and subadult females (June 1 to October 19) were recorded with similar colors, except that the comb was generally pale vermilion and the iris deep olive-brown to dark olive. In a downy chick of July 20 the bill was fuscous, with the tip and both tomia, as well as the base of the mandible, horn color; iris dark olive; nails plumbeous, with horn-color tips. In two juvenile males and three juvenile females (July 30 to August 13) the bill was generally fuscous, the base (and in some cases the median portion) of the mandible horn color; iris dark olive-brown; comb very pale orange-red or pale vermilion; nails horn color, dusky toward tip.

The wonderful insulating quality of the Willow Ptarmigan's dense plumage was illustrated in November, when I brought a frozen specimen into the cabin, where the temperature was roughly 60°, and kept it for about five hours before commencing the skinning operation. The body was still almost solidly frozen. The plumage presumably acts with similar efficiency in protecting the living bird from the rigors of the Arctic winter.

Distribution: Distributional records of the Willow Ptarmigan in adjacent regions include the following: to the eastward, Churchill and south of Eskimo Point (Preble, 1902: 103), Chesterfield and Nunalla (Sutton, 1931: 157), Boundary, Malaher, Boulder, and South Henik Lakes and other localities north to Yathkyed Lake (Manning, 1948: 12); to the northward, Repulse Bay (December specimens showing intergradation with *L. l. leucopterus*), Baker and Yathkyed Lakes, and (lower) Kazan River (Hørring, 1937: 26), and Perry River district (Gavin, 1947: 201—perhaps *L. l. leucopterus*); to the westward and northwestward, Athabaska, Great Slave, Artillery, and Great Bear Lakes and Anderson and Dubawnt Rivers (Preble, 1908: 342), Clinton-Colden and Aylmer Lakes (Preble, 1911: 376), Liverpool Bay, Franklin Bay, and Horton River (Anderson, 1913: 476), Thelon River (Critchell-Bullock, 1931: 15), and Hanbury River (Clarke, 1940: 48); to the southward, Reindeer Lake (in winter) (Preble, 1908: 342; Buchanan, 1920: 238).

Friedmann (1946: 101), in extending the breeding range south to "central Alberta, central Saskatchewan, and central Ontario," has obviously confused the breeding range with the winter range. He has erroneously included Fort Resolution and Fort Simpson in the breeding range, and he has overlooked the southern half of Keewatin as part of this range. Lincoln (in Bent, 1932: 189), like the author just quoted, includes Fort Resolution in the breeding range. All the available evidence indicates that in Mackenzie, Keewatin, and Manitoba the present subspecies is characteristically a summer bird of the Barren Grounds, breeding south only to the approximate limit of that region. Preble, with his usual discernment, wrote long ago (1908: 342) that the Willow Ptarmigan breeds "mainly in the Barren Grounds." In the localities in Manitoba and Keewatin where Manning (1948: 12) found the bird in the summer of 1945, it is significant that the "area of bush" or timber tracts nowhere exceeded an estimated 20 percent of the terrain, the remainder being Barrens. In so far as Keewatin is concerned, Sutton (1932: 88) is probably in error in regarding the ranges of *L. l. albus* and *L. l. leucopterus* as "not continuous" (*cf.* Clarke, 1940: 48).

The life-zone relationships of the breeding range of the weakly differentiated *L. l. ungavus* Riley, of the Ungava (or Labrador) Peninsula, seem to be imperfectly understood. Townsend and Allen (1907: 361), who apparently had no personal acquaintance with this Ptarmigan, give its status as that of "an abundant resident throughout Labrador *south of the tree line.*" They add that it "breeds in the interior of Labrador *in the forested region.*" (Italics in the above quotations not in the original.) Subsequent authors seem to have taken their cue from Townsend and Allen. Thus Hantzsch says (1929: 12): "The Willow Ptarmigan as a breeding bird inhabits only the more vegetatively favourable parts of Labrador, especially the wooded parts." Austin, who encountered exceedingly few Ptarmigan himself, writes in similar vein (1932: 76): "The Willow Ptarmigan is as typically a Hudsonian bird as can be found on the Labrador. It prefers the short, low, scrub growth, and is seldom to be found . . . north of the tree line." He immediately proceeds to undo his own statements by listing the following summer localities: Nain, Angutausugevik Brook (north of Nain), Alleuk Bight (near Hamilton Inlet), and Udjuktiok Bay (near Hopedale)—all of which are either on or beyond the "Northern Limit of Wooded Country" indicated on the National Geographic Society's map of Canada (1947). Sutton's views (1932: 88) are in line with those already quoted: "Along the Labrador coast and in the more southern part of Hudson Bay, these large ptarmigan [*L. lagopus*] usually extend in summer throughout the Hudsonian Life-Zone as far north as there are any scrubby trees. At this point their range apparently stops, and that of *rupestris* begins."

Undiscriminating acceptance of the foregoing statements would be unfortunate. The situation is complicated by Merriam, Bailey, Nelson, and Preble's Zone Map of North America (1910), which shows the Hudsonian Zone extending north without interruption to about latitude 56° 30′ N. on the east coast of Hudson Bay and to the south shore of Ungava Bay. However, within the region represented as this zone there is a vast extent of territory consisting of barrens or semi-barrens. As Ekblaw remarks (1926: 106), "Large areas within the limit of the [interior] plateau are composed of . . . tundra and tundra-moor vegetation." "To the northward of latitude 53°, the higher hills are treeless and the size and number of the barren areas rapidly increase. In latitude 55°, more than half the surface of the country is treeless." (Low, 1896: 31.) Furthermore, "The vegetation along the coast of the Labrador Peninsula is distinctly tundra, with no trace of forests except at the heads of the deeper inlets" (Ekblaw, 1926: 105). It is precisely this coastal strip that has furnished a large proportion of the summer records of the Ungava Willow Ptarmigan. The plant species listed by Ekblaw (1926: 105-106) from the coastal tundras are largely identical with those found on the Barren Grounds about Nueltin Lake.

Further indications of the treeless nature of much of the interior of the Ungava Peninsula may be found in the works of Mrs. Hubbard (1908), D. Wallace (1907), and Cabot (1912). It is amply evident that this interior is not fully occupied by the Hudsonian Zone, as one might assume from examination of the maps cited above, but is distinctly a mixture of the Arctic

and the Hudsonian Zones. The Hudsonian Zone proper is thoroughly wooded, chiefly with black spruce and tamarack. The isolated patches of these trees that are found within the borders of the Barren Grounds are to be regarded as outpost representatives of the Hudsonian Zone, within a predominantly Arctic Zone environment.

It is particularly significant that the recent investigations of Hustich (1949: 41, figs. 3, 4) have led him to set off practically all that part of the hitherto labeled Hudsonian Zone lying north of latitude 55° in Ungava as the Forest-Tundra Section, where "the forest occurs only in patches and the whole area is dominated by barren-ground with characteristic plant and animal life."

By analogy with *L. l. albus*, the Ungava Willow Ptarmigan should breed either within the Arctic Zone or on its very borders. Aside from the summer localities mentioned by Austin and listed above, the following are on record: Fort Chimo (Turner, 1885: 245); upper Hamilton River (Low, 1896: 325); Clearwater River (Low, 1898: 11); Lake Michikamats (Mrs. Hubbard, 1908: 151); various islands in James and Hudson Bays between Fort George and Richmond Gulf (Macoun and Macoun, 1909: 223-224); on the coast a little north of Davis Inlet and in the interior between Cabot and Mistinipi Lakes (Cabot, 1912: 57, 142, 231, 233); The Bluff Harbor (20 miles west of Cape Whittle) (Lewis, 1927: 64); George River and farther northward on Ungava Bay (Hantzsch, 1929: 12); Hopedale, Okak, and Nastopoka River (Bent, 1932: 198); Minto, Bush, and Scoter Lakes (Manning, 1947: 76, 80); Bienville and Gregory Lakes (Manning, 1949: 182); and Eastmain Hills, north of Lake Mistassini (Godfrey, 1949: 18). Probably the environment in practically every one of these localities is essentially the Arctic Zone, with, in some cases, a slight mixture of the Hudsonian. To quote Ekblaw (1926: 110) again, "On the barrens and semi-barrens [of the interior of Ungava], the willow ptarmigan . . . are common."

Incidentally, the breeding population of the north shore of the Gulf of St. Lawrence is not recognized or subspecifically determined in the A. O. U. *Check-List* of 1931. Friedmann (1946: 100) refers it to the subspecies *albus*, despite the fact that its distribution is more or less continuous with that of *ungavus* around the east coast of Labrador, whereas the nearest other breeding population of *albus* is possibly on the west coast of James Bay, some 800 miles distant!

It seems doubtful whether any race of the Willow Ptarmigan breeds in any extensive tract of coniferous woods (Hudsonian Zone), though many of the birds show a certain predilection for the borderland between forest and tundra, dotted here and there with small patches of spruce and tamarack as well as with thickets of shrubby willows, dwarf birch, and alder. All the breeding habitats indicated in Bent's life-history notes (1932: 178-202) on the various races seem to lie within the Barren Grounds or on their borders. I fully expect that the Willow Ptarmigan will eventually be found to breed throughout the Arctic Zone of the Ungava Peninsula, almost or quite up to Cape Wolstenholme.

Lagopus lagopus leucopterus Taverner, White-shafted Willow Ptarmigan. —On November 7 a blizzard from the north, that had commenced during the

previous night, continued all morning. In the early afternoon a flock of four Ptarmigan appeared among a little riverside growth of willow, dwarf birch, and *Calamagrostis canadensis* close to our cabin. All of them, when collected, proved to be males. Two are typical *L. l. albus*, while another is an aberrant individual or a hybrid, and is discussed under *albus*. The fourth (No. 1355) is distinguished by having the shafts of the first to seventh primaries partly whitish, especially on the basal half and at the tip. The greater part of the distal half of these shafts (especially the second) is more or less dusky, but this coloration is distinctly less intense than in the other birds. The shafts of the eighth to tenth primaries appear to be wholly white. The specimen thus corresponds closely to Taverner's description (1932a: 87) of mainland specimens of *L. l. leucopterus*, which show a certain degree of intergradation with *albus;* it may therefore be referred to *leucopterus*, though evidently somewhat intermediate. A further peculiarity of this specimen is the presence of a few brownish or blackish, white-tipped feathers on the cheeks, about the nostrils, and behind the eyes. Hørring (1937: 26, 27) records typical *leucopterus* from Melville Peninsula and King William Island in May and June, and intermediates between *albus* and *leucopterus* from Repulse Bay in December, when they may have been south of their summer range. The present specimen may be presumed to have originated on some breeding ground far up toward the Arctic coast, and to have migrated a distance of perhaps 500 miles. It evidently represents the southernmost record of the subspecies. A point of interest is its winter association with individuals of *albus*.

Dusky speckling near the tips of the two outermost primaries indicates that the bird was in its first autumn. Colors of the bare parts were noted as follows: bill black, tip of maxilla paler, and base of mandible plumbeous horn color; comb vermilion; iris warm brown; nails horn color, brownish basally. Nothing in these colors distinguishes the specimen from *albus*. There was the faintest suggestion of a delicate rosy pink flush on the plumage of the back and the under side of the wings. The specimen was somewhat fat; weight, 618.4 g. The testes (4×2.25 mm.) were pigmented. The wing measures 190 mm.—almost exactly the average for local first-autumn males of *albus*.

The breeding range of the White-shafted Willow Ptarmigan extends from Melville, Banks, and Victoria Islands east to Southampton and southern Baffin Islands and south to the Arctic coast at Dolphin and Union Strait (Taverner, 1932a: 87; 1946: 107), King William Island, and Melville Peninsula (Hørring, 1937: 27). Northward it extends to Prince Regent Inlet (Preble, 1902: 103), Brodeur Peninsula (Port Bowen) and Boothia (Preble, 1908: 342), and Admiralty Inlet (Bray, 1943: 516). The birds of the Perry River district (Gavin, 1947: 201) may be referable to this form. The area of intergradation between *leucopterus* and *albus* seems to coincide roughly with that between *Larus argentatus thayeri* and *L. a. smithsonianus* (*cf.* Rand, 1948c: 317, fig. 3).

Lagopus mutus rupestris (Gmelin), Hudson Bay Rock Ptarmigan.—On the Barren Grounds west of Hudson Bay, the breeding range of the Rock Ptarmigan apparently does not extend to their southern borders. In the Nueltin Lake region, despite a vague report of a very few birds noted

in summer, I secured no evidence of the species except as a winter visitor. The number of individuals recorded was approximately 149.

Autumn and winter activities: The birds began to appear in the vicinity of the Windy River post in October, but so sparingly that I myself found none until November. The southward migratory flight did not reach large proportions till approximately a month later than that of the Willow Ptarmigan. As early as October 9 Charles Schweder thought he heard a Rock Ptarmigan call. On the 14th Fred Schweder, Jr., saw a single individual near Four-hill Creek. On November 4 he reported a flock of about eight a mile up Little River from its mouth, and a few hours later I found the tracks, but not the birds, in that locality. On November 16 I secured two adult females from a flock of four among dwarf birches on a ridge in the Barrens. On the 19th a flock of about a dozen alighted on the ice at the head of Duck Bay, and presently worked inland over low Barrens where willows, dwarf birches, and probably some grasses and sedges projected above the snow. Perhaps a majority of the birds exhibited black lores—a very striking mark. As they moved actively about in their feeding, they made an unforgettable spectacle. Of two collected, one was an adult male and the other a subadult female.

On November 20 two Ptarmigan were noted among dwarf birches on the ridge beside our camp. One, with black lores, departed; the other, without this mark but presumably of the same species, ascended somehow into the low birch branches above the snow, making an odd sight. It was the only occasion on which I recall noting a Rock Ptarmigan perched above the ground. On the same day I heard a peculiar rolling note—*prrrrr, prrrrr*—just before a dozen birds or so came hurtling across the river, passing close by me. They had probably been alarmed by two falcons—apparently Gyrfalcons—that appeared circling over the river. The note described may be analogous to the *gwar, gwar* alarm note of the Willow Ptarmigan.

By this time, and during the remainder of my stay, the species was present in some force, very evidently outnumbering the Willow Ptarmigan. In fact, at this season it became the commonest bird in the vicinity of camp. On November 21 four flocks, numbering approximately 6, 25, 4, and 2 individuals, were noted. The first three of these flocks were flying across Windy River, in one direction or the other. Five specimens (all males) were collected among dwarf birches on the river bluffs. This species, in general, gave the definite impression of being less wary than the Willow Ptarmigan. It was frequently possible to secure either species with the "aux." Once, when two Rock Ptarmigan within a few yards of each other were collected in succession, the first shot did not cause the second bird to move off or to quit feeding.

On November 23 a visiting trapper reported half a dozen birds on the bluff by our camp, and I saw one of them. On the 25th Charles Schweder reported a bird near camp, and I saw a flock of about eight Ptarmigan on the far side of Windy River, but did not determine the species. On the same day Fred Schweder, Jr., saw four Rock Ptarmigan on a trip about a dozen miles up the Windy River. On a five-day trip, November 26 to 30, from Windy River to Putahow River and return, he reported seeing a good many Rock Ptarmigan (and none of the other species); some of these were well to the

southward in the "bush country" (Hudsonian Zone) near the mouth of Putahow River, which is situated in Manitoba.

On December 2 a flock of about eight appeared in a dwarf birch thicket near camp. They were somewhat shyer than most of the others I had encountered, and ran off over the snow about as fast as I walked toward them. I heard from one or more of them their distinctive alarm note—a low, rolling *prrrrr, prrrrr*. Even under these circumstances the birds gave no exhibition of the tail-agitating act, so commonly observed in the Willow Ptarmigan. Moreover, Fred Schweder, Jr., informed me that he had never noticed such a trait in the Rock Ptarmigan. As the more confiding of the two species, the latter might naturally be considered as less likely to express nervous agitation in the manner described.

Association with Willow Ptarmigan: During the short period of my observations on the Rock Ptarmigan, I found no definite evidence of its mixing in flocks with the Willow Ptarmigan. Some of the winter individuals so nearly or so completely lack the black lores that it would seem all but impossible to distinguish them in the field from the other species (unless by their notes). In general, therefore, it would be desirable to substantiate the identification of such birds with actual specimens. Charles Schweder stated that the two species occur in the same flocks, the Willow Ptarmigan always being in the majority. Anderson writes (1913: 477) that "The two species are commonly found together"; Clarke (1940: 49) and Porsild (1943: 27) give similar testimony.

Gait and footprints: In deep, soft snow, that does not support the birds well, both Ptarmigan exhibit a peculiar waddling gait, somehow reminiscent of a water turtle scrambling along on the land. The footprints of the Rock Ptarmigan impressed me as being smaller and placed closer together than those of the other species; also their legs appeared much thinner.

Spring migration: According to Fred Schweder, Jr., the Rock Ptarmigan move north in April and May, and are then seen in considerable numbers. In April, 1944, he spent a full day in the vicinity of "Pile o' Rocks," using a .44 rifle to shoot about 70 Ptarmigan, all being of the present species. They were used entirely for dog feed, presumably owing to a dearth of fish or caribou meat. The birds were present to the number of about a thousand, in flocks of 50 to 60 individuals.

Habitats: Most of the Rock Ptarmigan I saw were frequenting the growth of dwarf birch on the river bluffs or on ridges in the Barrens—the same habitat particularly favored by the Willow Ptarmigan. One flock fed over low Barrens. Charles Schweder spoke of finding the birds mostly in flat, open places in the Barrens; they roost in such places, and avoid the "bush country" or timber tracts.

Ectoparasites: Mallophaga were found on only three of the nine specimens secured (November 16 to 21). Each of these yielded *Lagopoecus* sp. and *Goniodes lagopi*. Both ectoparasites were found on the Willow Ptarmigan as well.

Plumages, measurements, weights, and gonads: Of the nine specimens collected, only eight are at hand. All are in the white winter plumage, but one subadult male (November 21) retains a vestige of the autumn plumage

(a dusky feather among the tertials, another among the under wing-coverts, a few black-and-buffy feathers on the crown, and several blackish ones on the throat). There are three males and two females in their second or later winters, and two males and one female in their first winter. The older (adult) group has wholly white primaries (except for the dark shaft streaks), wholly white primary coverts, and unworn first and second primaries with rounded tips. The younger (subadult) group is distinguished by an elongate dusky spot near the tip of the second primary, expanding on each side of the shaft; by a dusky speckling on the outermost primary covert; and, in general, by more or less visible wear on the two outermost primaries, which, moreover, are more pointed at the tip than those of the other group (*cf.* Petrides,, 1942: 314). Friedmann (1946: 109-127) provides no description of the first winter plumage in any subspecies of Rock Ptarmigan. November specimens in both age groups have the third primary longer than the second. The older birds have, on the average, greater weights and larger gonads than the younger ones; but there is no very marked difference in wing or tail lengths between the two groups. At similar ages the males in general have greater weights and longer wings and tails than the females. Three adult males: wing, 192, 187, 193 (190.7); tail, 101, 101, 108 (103.3); height of bill at angle of gonys, 7.75, 7.5, 7 (7.4); testes, 5×3.5, 5×3, 4×2.75; weight, 577.9, 602.2, 576.1 (585.4) g. Two adult females: wing: 180, 176 (178); tail, 90, 95 (92.5); height of bill, 7, 7 (7); ovary, 12×8, 14×7; weight, 512.4, 499.6 (506) g. Two subadult males: wing, 200, 186 (193); tail, 107, 101 (104); height of bill, 7, 7.5 (7.3); testes, 4×2, 4.5×2.25; weight, 514.9, 459.9 (487.4) g. One subadult female: wing, 180; tail, 101; height of bill, 7; ovary, 10×5; weight, 482.2 g. The birds varied from "slightly fat" to "rather fat." The dense feathering of the legs makes accurate measurement of the tarsus almost impossible; however, in four specimens this bone measured approximately 29.5-33 (31.1), compared with 39 in two adult males of *L. l. albus*. In the present specimens there is apparently no correlation between pigmentation of the testes and the age of the individual. In one adult and one subadult the testes were pigmented; in two adults and one subadult only the left one was pigmented. Salomonsen remarks (1939: 315) concerning *L. m. millaisi* in Scotland: "The testis in immature males reaches in Aug. the proportions of the neutral stage in the adult males." In the few specimens of *rupestris* examined, the size in the subadult males approximated that in the adult males, but averaged slightly less.

A comparison of adults of both sexes with those of the Willow Ptarmigan (all from the same circumscribed area) shows a difference of approximately 4 to 5 percent in wing length and 6 to 8 percent in body weight, the latter species being the larger bird. The difference in body size is readily apparent in made-up skins. Friedmann (1946: 101, 123), using a larger series of specimens from a much wider territory, indicates a slightly greater wing length in *L. m. rupestris* than in *L. l. albus*. Authorities in general (*e. g.*, Audubon, Coues, Chapman, Anderson, Taverner) agree on the larger size of the Willow Ptarmigan.

In one adult male Rock Ptarmigan the black loral patch is practically

twice as broad (10 mm.) as in any other specimen. According to Friedmann (1946: 122), the adult female in winter plumage is "without the black loreal stripe." However, Bent (1932: 207-208) is more correct in attributing "traces of black lores" to "some young males" and "some old females." In the present series two of the three subadult males have a well-developed black loral stripe (with postorbital continuation), and all three females (two adult, one subadult) show at least a trace of it. In one of the adult females there are distinct areas of white-tipped black feathers both before and behind the eye, not continuous above the eye and not extending to the bill (as in young and old males).

In all specimens the white plumage nearly throughout (except on legs and wing tips, revealed a faint rosy pink flush (barely apparent a little more than a year later). The rectrices are approximately black (darker than Fuscous-Black); the "dark clove brown" of Friedmann's description (1946: 122) is perhaps attributable to fading or discoloration in specimens prepared long ago.

Bare parts: There was little variation in the colors of the bare parts in the various specimens (male and female, adult and subadult): bill black, the extreme tip of the maxilla generally, and that of the mandible in some specimens, pale brownish; base of mandible plumbeous in two specimens (one a subadult female); comb vermilion (pale vermilion in a subadult female); iris deep olive-brown to dark brownish; nails horn color, basally brownish. Hantzsch states (1929: 14) that the bill is "sometimes lighter at tip"; Sutton (1932: 100), that it is "solid, glossy black."

Distribution: Charles Schweder spoke of having shot many Rock Ptarmigan in winter on the Kazan River about 10 miles below Ennadai Lake. On March 15, 1948, he wrote me concerning the Windy River area: "There have been very few Ptarmigan around lately, mostly Rock Ptarmigan."

On the west side of Hudson Bay, Preble (1902: 104) records the species as breeding at Cape Fullerton and wintering at Churchill and even York Factory (in severe seasons). Sutton (1932: 94) found it on Southampton Island throughout the year, and at Chesterfield in summer. Taverner and Sutton (1934: 31) have a single summer record (August 19) for Churchill. Hørring (1937: 28) presents numerous records from Pond Inlet on the north to Baker and Yathkyed Lakes and Eskimo Point on the south; apparently the birds breed throughout this range. The species occurs at Admiralty Inlet (Bray, 1943: 516). Gavin (1947: 201) found it a permanent resident in the Perry River district. Manning (1948: 13) reports it at Alder and Victory Lakes. To the westward and northwestward, there are winter records from Fort Reliance and Fort Rae on Great Slave Lake and from Great Bear Lake, and a summer record from between MacKay and Aylmer Lakes (Preble, 1908: 347); also a winter record from Ptarmigan (Casba) River (Critchell-Bullock, 1931: 15) and a summer record from Hanbury River (Clarke, 1940: 48). Anderson (1913: 477) mentions the following localities: Cape Bathurst, Franklin Bay, Coronation Gulf, and Victoria Island.

Some of the northernmost records of Rock Ptarmigan among the Arctic islands are from Prince Patrick and Melville Islands, Wellington Channel, and Brodeur Peninsula (Port Bowen) (Preble, 1908: 347).

Lincoln (in Bent, 1932: 212) extends the Rock Ptarmigan's range southward in Keewatin and Mackenzie only as far as Cape Fullerton and Bernard Harbour, which he places in "southern Franklin"; he also states that in winter the birds "do not appear to retreat beyond the southern limits of the breeding range." Friedmann (1946: 122) includes Great Slave Lake in the breeding range, and states that the species winters "possibly (rarely) farther south" than the breeding range. These statements are somewhat at variance with the distributional data assembled herein. Beyond question, the large numbers of Rock Ptarmigan that arrive at the edge of timber in the Windy River area in the fall have originated far out in the Barren Grounds.

Pedioecetes phasianellus phasianellus (Linnaeus), Northern Sharp-tailed Grouse.—My only records of this bird are of a few individuals seen from the Hudson Bay Railway on May 21: one several miles southwest of Amery; a probable flock of three near Weir River; and one a few miles south of Lawledge. Charles Schweder had never noticed this species on his frequent trips between Nueltin and Reindeer Lakes.

The northernmost previous records from Manitoba seem to have been at Oxford House and near York Factory (Preble, 1902: 104). Buchanan (1920) does not report the species from the Reindeer Lake area, nor does Manning (1948), from localities to the eastward. In the district of Mackenzie the range of the subspecies *P. p. kennicottii* extends northward nearly to the limit of trees in various localities: Mackenzie Delta, Lockhart and Anderson Rivers, and near the headwaters of Yellowknife River (Preble, 1908: 348). A useful distributional map has been published by Snyder (1935: 7).

Grus canadensis canadensis (Linnaeus), Little Brown Crane.—In 1944 or 1945, probably in May, two Little Brown Cranes appeared on a sedge bog near the mouth of Windy River, and one of them was shot by Charles Schweder. One or both wings were kept at the near-by camp where I had an opportunity to examine them. The species is not known to nest in the vicinity, and its migrations evidently do not take it past this area in any numbers or with any degree of regularity.

Preble (1902: 92) records the species from 25 miles south of Eskimo Point, Melville Peninsula, and Montreal Island; Blanchet (1930: 61), from Tavane; Sutton (1932: 101), from Southampton Island; Taverner and Sutton (1934: 32), from Churchill (rare transient), Nunalla, and Mistake Bay; Hørring (1937: 46), from Pond Inlet and Vansittart Island south to Baker Lake (breeding), Eskimo Point, and Egg Island, Hudson Bay; Bray (1943: 517), from Iglulik Island; Manning (1948: 13), from Carr and Baker Lakes and Christopher Island. Presumably the "thousands" reported by Gavin (1947: 201) as nesting in the Perry River district migrate by way of the Athabaska Valley rather than along the western side of Hudson Bay. Critchell-Bullock (1931: 14) and Clarke (1940: 50) found the species in the Thelon River and neighboring regions, from Clinton-Colden Lake in the west to Beverly Lake in the east. Preble (1908: 312) presents records from the Athabaska, Slave, Mackenzie, and Anderson Rivers and Great Slave Lake, north to Banks Island and Boothia Peninsula; Anderson (1913: 470), from Cape Bathurst. Buchanan (1920: 232) reports a southbound flock over Cochrane River, September 23.

Charadrius hiaticula semipalmatus Bonaparte, Semipalmated Plover.—This is apparently the only member of the plover family that breeds in the immediate vicinity of the Windy River. Its numbers here are rather limited; it was recorded on only 13 days from June 18 to August 16, and no more than four or five individuals were observed on any one day. The total of 22 individuals recorded doubtless includes a considerable number of "repeats." In 1947 the species apparently arrived nearly a month later, and departed a month earlier, than the extreme dates at Churchill (*cf.* Taverner and Sutton, 1934: 33). I did not have the good fortune to observe any of the courtship antics described by Sutton (1932: 106).

The habitats where the Ringneck was observed were the following (in order of frequency): ridges in the Barrens, sedge bogs, river shore, border of tundra pond, ice cake in Windy Bay, and camp dooryard. Here on its breeding grounds the species shows a predilection for bare areas of muck, just as it does for mud-flats on its migrations along the Atlantic Coast. Such areas of muck are found in some of the local sedge bogs or on the borders of tundra ponds, and the birds apparently do their main feeding there, while nesting on the adjoining gravelly and rocky ridges.

For the most part only a single pair seemed to frequent a given sedge bog; on June 24, however, a band of four birds was noted at one of these bogs. In its summer home the species utters the same call-notes as on its migrations: a plaintive *tyoo-eep'* and a shorter *kyoop*, the latter given either singly or in a series (*cf.* Nichols and Harper, 1916: 254). On one occasion the former note seemed to be shortened to *tyeep* by a pair of anxious birds. On July 3, on a gravelly ridge near one of the bogs, a Ringneck crept along in a crouching attitude, meanwhile giving the *tyoo-eep'* note; it was evidently concerned about nest or young. As late as August 6 a bird expressed parental anxiety by its actions. The last bird of the season appeared in the cabin dooryard in the twilight on August 16. In October some Eskimos from the upper Kazan River brought with them one or more crude skins of this species.

In western Canada the main breeding range of the Semipalmated Plover evidently lies in the Barren Grounds, although it has also been observed at various places in the more northerly parts of the wooded country at or near the nesting season. There are summer records from Churchill (Preble, 1902: 101; Taverner and Sutton, 1934: 33); Hayes River, York Factory, and 25 miles south of Eskimo Point (Preble, 1902: 101); Tavane (Blanchet, 1930: 61); Southampton Island, Whale Point, and Chesterfield (Sutton, 1932: 105); Eskimo Point, Chesterfield Inlet, Baker Lake, and other points northward to Melville Peninsula and Eclipse Sound (Hørring, 1937: 49); Somerset Island (Shortt and Peters, 1942: 343); Sandhill, Malaher, Boulder, and South Henik Lakes and Tha-anne River (Manning, 1948: 13); Perry River district (Gavin, 1947: 201); lower Slave River (July 3), Great Slave and Artillery Lakes, Anderson and Lockhart Rivers, Franklin Bay, Boothia, and Port Kennedy (Preble, 1908: 335); Aylmer Lake (Preble, 1911: 375); junction of Tazin and Talston Rivers (July 31—Harper, MS); near Campbell and Sifton Lakes (Critchell-Bullock, 1931: 15); Hanbury and Thelon Rivers and Nonacho, Heuss, and Smart Lakes (Clarke, 1940: 50); and Cochrane River (July 23—Buchanan, 1920: 236).

Charadrius vociferus vociferus Linnaeus, Killdeer.—On June 10 one or two Killdeers were seen at a sedge bog and on the adjacent Barrens near the mouth of Windy River.

The species nests at Churchill (Preble, 1902: 101; Taverner and Sutton, 1934: 33; Grinnell and Palmer, 1941: 49). In the Athabaska-Mackenzie region it has been found as far north as Fitzgerald (Smith Landing) and Fort Resolution (Preble, 1908: 334). There seems to be no previous record from Keewatin.

Capella gallinago delicata (Ord), Wilson's Snipe.—As a species breeding more or less throughout the wooded country to the very edge of the Barren Grounds, Wilson's Snipe occurs in small numbers in the Windy River area. Its primary habitat is the sedge bogs, which serve as a focus for its aerial evolutions; a single bird was noted in a riverside meadow. There were probably more auditory than visual records; most of the birds seen were in the air. A mere handful of individuals probably furnished most of the 17 or 18 records secured.

The extreme dates of observation were June 5 and September 3. The maximum number noted per day was only two; generally there was only one. Winnowing was heard first on June 10; and thereafter at intervals of no more than a few days till July 9. The short hours of semi-darkness during the summer nights seemed to be the principal, though not the only, period for this aerial activity. It was a common experience to be serenaded with the eerie Aeolian music as I retired in the twilight to my tent on a ridge not far from a sedge bog. It continued at intervals through some of the nights. The performer sweeps about overhead at a great rate in a rather erratic course, apparently both clockwise and counterclockwise. It spreads its tail and makes a slight downward swoop to produce the winnowing sound. The call-note, *scaipe*, was heard only a few times during the entire season. The only observation after July 9 was made on September 3; the bird was flushed among sphagnum, willow, and dwarf birch near the edge of a sedge bog.

Between Nueltin Lake and the more northerly parts of Hudson Bay Wilson's Snipe seems to have been recorded only at Churchill (Preble, 1902: 94; Taverner and Sutton, 1934: 35) and at Eskimo Point (Sutton, 1931: 157). To the westward and northwestward, it has been recorded at Forts Chipewyan, Smith, Resolution, Rae, and Anderson, and Dease River (Preble, 1908: 317), and on the Thelon River (Clarke, 1040: 50); to the southward, near Du Brochet Lake (Buchanan, 1920: 233).

Numenius phaeopus hudsonicus Latham, Hudsonian Curlew.—The following information on the local status of this species was secured from Charles Schweder. In former years he never saw one at the "Old Post" above Simons' Lake. His only record for the vicinity of the mouth of Windy River is a single curlew (presumably a Hudsonian) seen on June 6, 1947. In the region of the upper Kazan River the birds nest in a number of places, one being on the northwestern side of Loon Lake, about 30 miles north of Windy River. Here Charles saw an adult with four young ones that were on the wing, about the middle of August, 1945. Another place is Big Lake, about 5 miles south of the upper Kazan. Here Fred Schweder, Jr., found a nest with four fresh eggs about June 24, 1947, when four old birds

were seen in the vicinity. During that month Charles saw a total of nine curlews on a trip from the Windy River to the Kazan and return. The local curlews have bills about 4 inches long. They nest in open sphagnous bogs rather than in the sedge bogs.

These reports constitute an interesting addition to the information assembled by Taverner (1942: 3), who had no records "between Anderson River and the west coast of Hudson Bay."

To the eastward, the Hudsonian Curlew has been recorded in the following localities: 50 miles north of York Factory, Churchill and vicinity, below Hubbart Point, and south of Eskimo Point (Preble, 1902: 100); Southampton Island and Chesterfield (Sutton, 1932: 119); Churchill (Taverner and Sutton, 1934: 36); Malaher and Boundary Lakes and Tha-anne River (Manning, 1948: 13). Taverner (1942: 3) mentions sporadic occurrences on Melville Peninsula and at Arctic Bay. To the westward and northwestward, there are records from Great Slave and Great Bear Lakes and Anderson River and vicinity (Preble, 1908: 331).

Actitis macularia (Linné), Spotted Sandpiper.—The Spotted and the Least Sandpipers are evidently the commonest shore birds of the Windy River area. The former was noted at very frequent intervals from June 14 to September 13, but only in very small numbers—generally only one or two per day. The approximately 51 records I secured were doubtless provided by comparatively few individuals. The species showed a very marked predilection for feeding on the immediate shores of Windy River (fig. 2) and Windy Bay. It also resorted for nesting purposes to the adjacent gravelly and rocky ridges in the Barrens. Two or three appeared in the cabin dooryard.

On the day of their arrival (June 14) the birds were calling *weet-weet-weet*. Calls of one sort or another were heard rather frequently up to August 18, but none were recorded thereafter. On August 17 an adult was calling *peet-eet, peet-eet*.

On July 24 a nest with four eggs was found on a gravelly ridge forming a promontory at the mouth of Windy River (close to the site shown in fig. 6). It was beneath the outer twigs of a low clump of dwarf birch, and surrounded by sticks (placed there by the bird), mountain cranberry, and *Cladonia*. On several visits to the nest no parent bird could be found till August 6, when the eggs had hatched and one of the young ones was preserved. As late as August 18 an adult on the opposite side of the river was acting as if anxious concerning young ones. On August 16 an adult was changing from summer to winter plumage.

The downy secured in the nest on August 6 weighed 6.35 g.; it was somewhat fat. Its bill was plumbeous gray; iris dark brown; tarsus and toes plumbeous skin color, with some dusky spots. Though perhaps only a few hours old, the specimen yielded a mallophagan, *Quadraceps rava*.

Between Nueltin Lake and Hudson Bay the Spotted Sandpiper has been recorded at York Factory (Preble, 1902: 99), Churchill (Preble, 1902: 99; Taverner and Sutton, 1934: 37), and Big Sand, Neck, and Sandhill Lakes (Manning, 1948: 13). To the westward and northwestward, it has been found at Athabaska, Great Slave, Great Bear, Clinton-Colden, and Aylmer

Lakes and Anderson and Lockhart Rivers (Preble, 1908: 329) and the Hanbury and Thelon Rivers (Clarke, 1940: 51); to the southward, at Reindeer and Cochrane Rivers and Reindeer Lake (Buchanan, 1920: 235). There was apparently no previous record from Keewatin. In general the species does not seem to range north of the wooded country; but Clinton-Colden and Aylmer Lakes are in the Barren Grounds proper, and there are only small patches of timber along the Hanbury and Thelon Rivers.

Totanus flavipes (Gmelin), Lesser Yellowlegs.—From June 4 to 16 the Lesser Yellowlegs noisily advertised its presence about the mouth of Windy River, though its numbers were very small, no more than three or four birds being noted per day. Thereafter it all but disappeared, a single bird being seen on June 24 and two on August 8. Most of the birds were observed at various sedge bogs, which obviously constitute the primary habitat in this area. My records of approximately 21 occurrences may have been based upon only about half a dozen birds.

The most commonly heard note was a musical *tyool-doo, tyool-doo,* which seems to be especially characteristic of the nuptial season; it generally came from birds on the wing. Another was an indefinitely repeated *kyoo-kyoo-kyoo,* etc., indicating anxiety or alarm. The latter is uttered both on the wing and from a perch. On June 9 a bird giving the *tyool-doo* note slanted down on set wings to alight on the top of a small spruce beside a sedge bog; it kept its wings uplifted high in a characteristic attitude for a moment or two after alighting. On the following day, at another sedge bog, two Lesser Yellowlegs came flying in, at least one of them giving the *kyoo-kyoo-kyoo* note. After alighting gracefully, one of the birds continued this note by the minute, meanwhile walking about as if feeding, but barely pausing to peck at something. Then it stood on a tuft of grass or sedge while eyeing me and rapidly opening and closing its bill; it now bobbed its head more definitely than it had while walking about. Late in the evening of June 16 a bird dropped into a small bog, giving the *tyool-doo* note, while another, at a distance, gave the whistle commonly heard on migration—a single *wheu* or a double *wheu-wheu.* This whistle was recorded on no other occasion.

On August 8 a bird flew about anxiously and rather slowly as I walked over a ridge near a tundra pond. It alighted on the ridge, on the tips of spruces, and on a rock in the edge of the pond, meanwhile giving the *kyoo-kyoo-kyoo* note incessantly. On the same day another bird protested my presence while it flew from spruce to spruce in thick timber. These actions presumably indicated the presence of unseen young ones.

At the nesting season the Lesser Yellowlegs is not limited to the wooded country of the Canadian and Hudsonian Zones, but ventures for some distance into the Barren Grounds. Between Nueltin Lake and Hudson Bay it has been recorded at Churchill (Preble, 1902: 98; Taverner and Sutton, 1934: 40); 50 miles south of Eskimo Point (Preble, 1902: 98); at Chesterfield (Sutton, 1931: 158); on the upper Tha-anne River (Porsild, in Clarke, 1940: 52); and at Big Sand, Sandhill, and Malaher Lakes (Manning, 1948: 14). To the westward and northwestward, it has been found at Great Slave, Great Bear, and Ptarmigan (Casba) Lakes and on the Slave, Grandin, Anderson, and Horton Rivers (Preble, 1908: 326); at Artillery Lake

(Blanchet, 1925: 53); and on the Thelon and upper Taltson Rivers (Clarke, 1940: 52). Buchanan (1920: 234) records it from Cochrane River and Du Brochet Lake.

Erolia melanotos (Vieillot), Pectoral Sandpiper.—At a sedge bog near the mouth of Windy River, on June 10, three sandpipers flew overhead. One, apparently with inflated breast and set wings, made a remarkable booming noise; then it separated from the other two and returned to the bog. Although I did not obtain a satisfactory view of the bird's plumage, its voice and behavior corresponded so well with those of the Pectoral Sandpiper, as described by Nelson (1887: 109) in Alaska, that I have little doubt that it belonged to that species.

On August 25 a sandpiper arose from the shore of Windy River with a rolling note, *krrrr;* and two others, similar to it, flew up from the border of Duck Bay. On September 13 another Sandpiper flew down the river in erratic flight, uttering a note like that just described. All of these autumn birds appeared larger than the smaller species of Scolopacidae, and probably all of them were Pectoral Sandpipers.

In a female collected at a sedge bog on June 5, the bill was mostly black, but brownish at the base of the mandible; iris deep olive-brown; legs and feet yellowish olive; ovary much enlarged. The bird was extremely fat and weighed 61.4 g.

Along the west side of Hudson Bay the Pectoral Sandpiper has been recorded 50 miles north of York Factory, at Button Bay, and south of Eskimo Point (Preble, 1902: 96); also at Churchill (Taverner and Sutton, 1934: 40). To the northward, eggs have been taken at Cambridge Bay (Preble, 1908: 321); the bird is uncommon on Southampton Island (Sutton, 1932: 126) and common in the Perry River district (Gavin, 1947: 201). To the westward and northwestward, there are records from Great Slave and Great Bear Lakes and Fort Anderson (Preble, 1908: 320); Cape Bathurst and Coronation Gulf (Anderson, 1913: 472); Clinton-Colden Lake and east of Lac de Gras (Blanchet, 1925: 53); Prairie and Hoare Lakes and the Hanbury-Thelon junction (Clarke, 1940: 52).

Erolia bairdii (Coues), Baird's Sandpiper.—While this species follows the migratory highway of the Athabaska and Mackenzie River valleys in very considerable numbers, its status in the Nueltin Lake region is obviously very different. My only observation was of two birds on the Barrens near the mouth of Windy River on June 10. Their size (a little larger than the Semipalmated or Least Sandpipers), the conspicuous light edges to the feathers of the upper parts, and their call-note (somewhat like that of a Semipalmate) led me to identify them as Baird's Sandpipers.

The only previously recorded localities for this species on the west side of Hudson Bay seem to be Churchill (Taverner and Sutton, 1934: 42) and Southampton Island and Chesterfield (Sutton, 1932: 136); in these localities its status is apparently that of a transient. Along the Arctic coast and islands to the northward, it is known from the Anderson River region and Cambridge Bay (Preble, 1908: 321), Victoria Island and Coronation Gulf (Anderson, 1913: 472), Kent Peninsula, King William, Danish, and Dope Vai Islands,

and Gore Bay (Hørring, 1937: 55), and Arctic Bay and Somerset Island (Shortt and Peters, 1942: 344). On the mainland south of the Arctic coast, Clarke (1940: 52) reports transients on the Thelon River and Artillery and Schultz Lakes, and Preble (1908: 321) gives records from Athabaska, Great Slave, and Aylmer Lakes and Ptarmigan (Casba) River. Buchanan (1920: 234) found the species at Reindeer Lake and Cochrane River.

Erolia minutilla (Vieillot), Least Sandpiper.—In the Nueltin Lake region, where no shore bird can be considered really common, the Least Sandpiper is met with as often as any other except the Spotted Sandpiper. The first one was observed on June 5; the last, on August 18. In the meantime scarcely more than two or three individuals were noted on any one day. In the early part of the season the species was seen rather infrequently (on five days in June and seven days in July); but it became more noticeable after the hatching of the young, and it was recorded on 11 days in August. Owing to "repeats" the total number of recorded occurrences (approximately 37) was no doubt much greater than the number of different individuals seen.

During June and July the main habitat and the nesting ground as well were the sedge bogs. On being disturbed from a nest in such a situation, a bird would go trailing over the ground with head low, back feathers fluffed up, tail widely spread, and wings fluttering. Meanwhile it would give a soft call something like *weep, weep;* or, after retiring to a little distance, it might give voice to a soft trill: *crrrrrrrp, crrrrrrrp.* Once, after being flushed, a bird presently flew over my head with a flight song—*creeeeeep-creeeeeep* (longer than the similar-sounding call-note), and then pitched down. A few minutes later it crept up, sparrowlike, through the bog vegetation and settled down on the nest. On June 30 the sitting bird allowed me to approach within 10 feet. On the next day, while I was operating a camera at the nest, it walked about at the same distance. Only one bird put in an appearance in the vicinity. The low bog vegetation in proximity to the nest included grass, dwarf birth, narrow-leaved Labrador tea, and bog rosemary.

On July 19, in the vicinity of another bog, a bird exhibited its solicitude in various ways—flying near me, hovering in the air, uttering a trilling note like the one described above, and also giving the call-note commonly heard on migration along the Atlantic Coast (*creeeep*). Finally it trailed over the ground. No doubt some young ones were near by. On July 20, 23, and 26 perhaps the same bird showed similar anxiety, alighting at different times on a dead willow or on the tip of a spruce, each about 5 feet high. In giving the trilling note, it was much inclined to sail on set wings or to hover against the wind.

After hatching, the young ones seem inclined to leave the bogs and resort to the adjacent gravelly ridges in the Barrens. On July 24 and 27 a Least Sandpiper flew up from the proximity of a Spotted Sandpiper's nest on such a ridge at the mouth of Windy River, and put on its usual performance of solicitude. On the second occasion it kept flying and fluttering as it uttered the soft trilling note, without setting its wings. On August 4, at a similar ridge near Little River, an adult not only behaved as just described, but also skimmed close over the ground with spread tail as well as fluttering wings. Presently a young one was detected there and collected; though able to fly, it

still retained a little down on the nape. A similarly plumaged juvenile was collected on the shore of Windy River on August 7, and another was seen there on August 10.

Most of the Least Sandpipers observed during August were on the river shore, and nearly all of them were solitary. Several appeared in the camp dooryard, and one in a riverside meadow. Most of the August birds were silent while under observation, but one or two gave the migration call (*creeeep*).

As noted above, an adult was distinguished at least as late as August 4, although Taverner and Sutton (1934: 42) indicate that only birds of the year are left at Churchill by the end of July.

In an adult male of June 5 the bill was black; legs and feet yellowish olive; testes 5.5×3.5; it was extremely fat and weighed 21.45 g. In the two juvenile males of August 4 and 7 the bill was fuscous (base of mandible paler in one); iris very dark olive-brown; tarsus yellowish olive; toes a little darker; testes 1.75 and 1.25 mm. in length. One bird was slightly fat and weighed 18.7 g.; the other was rather fat and weighed 17.8 g.

The two juveniles yielded the following Mallophaga: *Saemundssonia* sp. (larva) and *Carduiceps complexiva*.

On the west side of Hudson Bay the Least Sandpiper has been recorded at Churchill, Button Bay, and south of Eskimo Point (Preble, 1902: 96), and at Big Sand, Sandhill, Boundary, Malaher, Boulder, South Henik, Camp, and Carr Lakes and Tha-anne River (Manning, 1948: 14); to the northward of Nueltin Lake, at Cambridge Bay (Preble, 1908: 322) and at Cape Fullerton (Lincoln, in Bent, 1927: 209); to the westward and northwestward, at Great Slave and Great Bear Lakes, Fort Anderson, and Franklin Bay (Preble, 1908: 322), and on the Thelon River (Clarke, 1940: 52); to the southward, at Reindeer Lake and Cochrane River (Buchanan, 1920: 234). Taverner's statement (1926: 139) that the species breeds "south of the Barren Grounds" requires amplification.

Micropalama himantopus (Bonaparte), Stilt Sandpiper.—This species was observed only as a spring transient in the Windy River area. Several flocks, of about four to a dozen individuals each, and numbering about 31 in the aggregate, frequented a couple of sedge bogs on June 5, 9, and 10, as these were rapidly becoming thawed out from their winter condition. Half a dozen of the dainty birds, in rather close array, made a pretty picture as they probed in the muck of a bog, operating their bills like little power drills. When taking wing, they would give a guttural *tyoo* note, and on alighting, they would keep their wings uplifted for a moment, in the manner of a Lesser Yellowlegs. On occasion the call-note seemed to be uttered in a series.

On the west side of Hudson Bay the Stilt Sandpiper has been recorded 50 miles north of York Factory and 25 miles south of Eskimo Point (Preble, 1902: 95); at Tavane (Blanchet, 1930: 61); at Churchill (Taverner and Sutton, 1934: 45); and at Boundary and Boulder Lakes (Manning, 1948: 14). It nests on the Arctic coast in the Perry River district (Gavin, 1947: 201). To the westward and northwestward from Nueltin Lake, there are records from Athabaska and Great Slave Lakes, Fort Anderson, Franklin Bay, and Langton Harbor (Preble, 1908: 319); Kogaryuak River (18 miles

east of Coppermine River) (Anderson, 1913: 472); Ptarmigan (Casba) River and Clinton-Colden Lake (Blanchet, 1925: 53); and Plover, Prairie, and Sifton Lakes (Clarke, 1940: 52).

Stercorarius parasiticus (Linnaeus), Parasitic Jaeger.—During the period from June 4 to 12 single Jaegers, apparently of this species, were seen on six days in the Windy River area. At this time open water was beginning to appear in the river, but the final break-up had not taken place. Most of the birds were flying over the river, where a band of Herring Gulls were frequently occupying a stretch of open water and consuming refuse from the camp; one alighted on the bank, and one appeared over a sedge bog. They were quite wary, as usual, and generally kept well out of range. These Jaegers evidently did not nest in the vicinity, for none were seen after June 12.

Preble (1902: 78) records the Parasitic Jaeger from 50 miles north of York Factory, Churchill, and south of Eskimo Point; Sutton (1932: 159), from Southampton Island, Roe's Welcome, and Chesterfield; Taverner and Sutton (1934: 51) and Allen (1946: 315, fig.), from Churchill; Manning (1948: 15), from Tha-anne River and Camp, Victory, Ninety-seven, and Twin Lakes. Hørring (1937: 81) mentions numerous localities, from Pond Inlet, Eclipse Sound, and Kent Peninsula in the north to Frozen Strait, Fullerton, and Baker Lake in the south. Shortt and Peters (1942: 344) report it from Ellesmere Land and Somerset Island. Gavin (1947: 202) found it in the Perry River district. To the westward and northwestward, there are records from Great Slave, Great Bear, and Clinton-Colden Lakes, Fort Anderson, and Melville Island (Preble, 1908: 261); Ptarmigan (Casba) and Aylmer Lakes (Preble, 1911: 361); and Thelon River (Critchell-Bullock, 1931: 12).

Stercorarius longicaudus Vieillot, Long-tailed Jaeger.—On August 31 Fred Schweder, Jr., saw three Long-tailed Jaegers sitting in a bog 5 miles north of Windy River, and shot one of them, an adult female. One of the others looked like this one and was presumably adult; the third was darker, with shorter central tail-feathers, and probably a bird of the year. I was particularly pleased at an opportunity, the first one in my experience, to make up a specimen of a Jaeger. Its bill, toes, webs, and nails were black; middle portion of tarsus plumbeous; rest of tarsus and lower tibia black. The ovary was reduced, measuring 16×4 mm. The bird was excessively fat and weighed 351 g. The extent of its wings was 1033 mm. Its vent and intestines were stained purple from berries it had eaten. In its proventriculus and stomach were bog bilberries (*Vaccinium uliginosum*) and a piece of paper bag! The latter was roughly 2 inches square. Bog billberries have likewise been reported in the stomachs of three out of 12 individuals in Greenland (Cottam and Hanson, 1938: 417).

Numerous mites (Epidermoptidae?) were preserved, chiefly from the wing.

This is the only species of Jaeger that Fred Schweder, Jr., observes locally during the summer, the Parasitic Jaeger being seen only in the spring. It frequents the bogs and the Barrens rather than Nueltin Lake. He has never seen the species in pursuit of a tern, but has seen Arctic Terns chasing it about a small lake 30 miles north of Windy River. Sometimes, he reports,

these Jaegers will feed upon a Caribou carcass. He has noticed them as late as mid-September.

In Manitoba and Keewatin the Long-tailed Jaeger has been recorded near York Factory, at Churchill, and at Southampton Island (Preble, 1902: 78); at Southampton Island and Roe's Welcome (Sutton, 1932: 164); at Churchill (Taverner and Sutton, 1934: 52); in the Perry River district (Gavin, 1947: 202); at Tha-anne River and Boulder, Camp, Carr, Victory, and Baker Lakes (Manning, 1948: 15). Høtring (1937: 82) mentions the following localities in Franklin: Genbo Island (Hurd Channel), Pond Inlet, and Eclipse Sound; Shortt and Peters (1942: 344), Somerset Island and Prince Regent Inlet; and Bray (1943: 527), Melville Peninsula. Westward and northwestward, there are records from Melville Island, Franklin Bay, Anderson River, and Fort Rae (Preble, 1908: 262); north and west of Artillery Lake (Blanchet, 1925: 52); and from the Thelon River (Clarke, 1940: 54).

Larus argentatus smithsonianus Coues, American Herring Gull.—From May 26 to 31 Herring Gulls were fairly common about Churchill. On the 26th a dozen or more were on Hudson Bay off the mouth of the river—some standing on the edge of the ice, others sitting on the open water or flying above it. On the 30th and 31st approximately 25 were seen at the air base and vicinity, chiefly at a pool in the landing field or at a refuse heap. A bird was heard calling at Duck Lake on the 31st.

In the Windy River area there were tracks in the camp dooryard on May 31, and the species was noted quite commonly and regularly from June 1 to September 28. During the first few days there was no open water on the river and lake within several miles of camp, although the sedge bogs were thawing out. The birds now seemed to depend for their main sustenance on refuse from the camp and on bodies of freshly killed Caribou. They were such thorough-going scavengers that they might be said to fill here somewhat the same ecological niche that vultures do in the Southern States. Other food was available in the form of last year's berries of *Vaccinium vitis-idaea, Empetrum,* and *Arctostaphylos alpina.* Up to June 12 the birds were commonly seen in daily numbers up to 10, 15, or 25, while on June 4 about 100 of them appeared at a spot where several Caribou had been killed the previous day. This suggests a habit of ranging far and wide to locate possible sources of food. Their depredations lead the hunters to cut off the head of a Caribou and with it to block the entrance to the abdominal cavity after evisceration, as described by Downes (1943: 228); the birds can not very readily penetrate the animal's hide. After eight days one of the bodies so protected had been little damaged, while another near by (probably not protected) had been almost entirely consumed.

Among a dozen or more birds that were feeding on June 12 on camp refuse thrown into a stretch of open water on Windy River, several tilted forward in the manner of the surface-feeding ducks, plunging their heads beneath the surface and pointing their tails to the zenith. Stone (1937: 535) refers to such behavior as apparently uncommon in this species.

While the Herring Gulls congregated in flocks at the areas of open water or about the caribou bodies, there was apparently some evidence of going by

pairs as early as June 6. The birds were quite noisy, and might be heard calling even during the night. Theirs is a weird and varied collection of notes, difficult to represent satisfactorily. The calls, while heard throughout the season, are apparently more frequent in the early part. A bird sailing calmly along called *keh, keh, keh.* Again one might utter a sort of wailing note: *keerh, keerh, keerh.* A bird flying down the river gave at short intervals a high-pitched, rather plaintive *kow; kow; kow.* On another day a note represented by the same letters sounded soft and rather nasal. Still another call was jotted down as *kyoo-kyoo-kyoo-kyoo-kyoo-kyoo.* While I was at Josie's Bay in July, a Herring Gull gave an exceptionally weird and unearthly cry, which I can not attempt to represent on paper. Other notes, uttered in protest in the vicinity of a nest, are mentioned below.

After the break-up on June 14, the Herring Gulls evidently dispersed to their breeding territories; during the rest of the season they were generally seen only by ones or twos—rarely more. On one of the exceptional occasions (June 27) half a dozen had gathered at a rotten caribou carcass. Again, on August 19, a similar number had been attracted to a fresh carcass. On August 27 a flock of about eight was flying up the valley of Little River.

The great majority of my observations were of birds flying up or down the Windy and Little Rivers in the vicinity of camp. Smaller numbers were noted on occasional trips to Windy Bay, and also during a sojourn at Josie's Bay in mid-July. Those seen on the ground in the Barrens had been attracted in practically every case by caribou bodies.

According to Charles Schweder, the local Herring Gulls never nest in colonies, but merely by isolated pairs on rocks in the lakes. Perhaps this abandonment of the normal colonial nesting habit is correlated with a limited supply of regularly available food (such as fish). On July 19 a nest with two or three downy young ones was noted on a rock a little offshore from an island in Windy Bay. An adult greeted the intruders with a shrill *keeouw, keeouw,* etc. Presently it changed to a complaining *kah-kah-kah-kah* as it charged and swooped fairly low over the canoe. This succession or change of notes seemed to represent regular procedure in the vicinity of a nest. It was not until September 8 that the first bird of the year in dark plumage was noted on the wing. I observed single birds in similar plumage on September 19, 27, and 28, while the final one of the season was reported by Charles Schweder on October 4. The last adults had been noted on September 19. To judge by the very small number of immature birds in evidence in the fall, 1947 would appear to have been a poor breeding season for Herring Gulls in this region. It was likewise a very poor season for fishes—a possible case of cause and effect.

On various occasions (July 6, August 2, 4, and 26, and probably other days) solitary Herring Gulls were observed standing for considerable periods on rocks in the edge of Windy or Little Rivers, near their mouths. One of the rocks, across the river from camp, seemed to be a habitual perch. The probable object of these vigils was revealed on August 2, when Fred Schweder, Jr., reported such a bird plunging into the water, coming up with a squirming, 1-foot Grayling (*Thymallus signifer*), and then flying off up the river with its booty. Forbush remarks (1925, 1: 78) that the Herring Gull "finds it

difficult to catch large, healthy, active fish except under particular favorable circumstances." (*Cf.* Townsend, in Bent, 1921: 110).

The total number of individuals recorded in the Nueltin Lake region, including an indefinite proportion of "repeats," was approximately 432.

An adult male, trapped by Eskimos at a lake about 10 miles northeast of Ennadai Lake, on August 10, was kindly brought to me by Dr. Robert F. Yule. Its bill was corn yellow, with a horn-colored tip and with an orange-red spot near the angle of the gonys; eye-ring dull orange; iris straw- or cream-colored; legs, feet, and webs pinkish skin color; testes 7×5 mm. The specimen was not fat, and weighed approximately 2½ pounds. Its stomach contained fat and fur. Dr. Yule also brought a skin, minus head and primaries, that had been used as a plaything by Eskimo children in the same locality; it is of interest mainly as an ethnological object.

In the region bordering the west side of Hudson Bay, the Herring Gull has been recorded at Churchill (Preble, 1902: 79; Taverner and Sutton, 1934: 53); at Tavane (Blanchet, 1930: 62); at Chesterfield and Nunalla (Sutton, 1931: 159); at Repulse Bay (Bray, 1943: 528); at Big Sand, Neck, Sandhill, Boundary, Malaher, Boulder, South Henik, Camp, Carr, Alder, Victory, Ninety-seven, and Twin Lakes, Tha-anne River, and Kazan Falls (Manning, 1948: 16). It breeds abundantly on Southampton Island (Sutton, 1932: 174). According to Hørring (1937: 68) and Rand (1948c: 317, fig. 3), the breeding birds from Melville and Kent Peninsulas and Coronation Gulf northward belong to the subspecies *L. a. thayeri;* while Gavin (1947: 202) reports two forms breeding in the Perry River district. To the westward and northwestward, there are records from Athabaska, Great Slave, and Great Bear Lakes and Anderson and Horton Rivers (Preble, 1908: 264); Artillery, Ptarmigan (Casba), Clinton-Colden, and Aylmer Lakes (Preble, 1911: 361); Hanbury and Thelon Rivers (Critchell-Bullock, 1931: 13); and Aberdeen Lake (Clarke, 1940: 54).

Larus delawarensis Ord, Ring-billed Gull.—The Nueltin Lake region apparently constitutes one of the outposts in the range of the Ring-billed Gull. I observed it on only three days in June and one day in August, and I obtained no information as to its nesting in the region.

On June 15 a gull with a narrow black band on its tail appeared at a distance over Windy River. On June 27 a gull with a similar tail and a ring on its bill was associating with half a dozen Herring Gulls at a rotten caribou carcass beside a tundra pond. On June 30 about three out of six gulls flushed from some caribou remains on the Barrens beside a sedge bog revealed the same characters as the one last mentioned, and also a considerable amount of black at the wing tips (which helps to distinguish this species from the Herring Gull). It will be noted that all of these June birds were in their second or third year, lacking the plumage of full maturity; also that most of them were exhibiting scavenger traits like those of the Herring Gulls. On August 27 an adult was observed over the river; its comparatively small size, ring on bill, and large amount of black at the wing tip served to identify it.

The nearest previous records are at a long distance from Nueltin Lake, as well as few: 50 miles south of Eskimo Point (Preble, 1902: 79); Lake

Athabaska, Slave River, and Great Slave Lake (Preble, 1908: 267).

Sterna paradisaea Pontoppidan, Arctic Tern.—The scarcity of Arctic Terns in the Nueltin Lake region probably reflects an insufficiency in the available supply of small fishes in the surface waters. Nine-spined Sticklebacks (*Pungitius pungitius*) are by no means abundant, and the skulking habits of the Sculpins (*Cottus cognatus*) must place them largely out of reach of terns. No minnows (Cyprinidae) are known in the region, and the immature stages of larger fishes are but little in evidence.

I secured only two or three glimpses of terns during the entire season—a single bird over Windy River on June 15 (the day after the break-up) and from one to three on Windy Bay on July 10. They were too distant for specific determination, but no other species of tern seems likely to occur here. The largest number of Arctic Terns that Fred Schweder, Jr., has found nesting together was five pairs, on a small island near The Narrows of Nueltin Lake.

Between this lake and Hudson Bay the Arctic Tern has been recorded 50 miles north of York Factory, at Churchill and vicinity, and near Eskimo Point (Preble, 1902: 81); at Tavane (Blanchet, 1930: 61); at Churchill and Cape Churchill (Taverner and Sutton, 1934: 56); at Sandhill, Malaher, Boulder, and South Henik Lakes and Tha-anne River (Manning, 1948: 16). To the northward, it is reported at Southampton Island and Roe's Welcome (Sutton, 1932: 189); at Yathkyed and Baker Lakes, Chesterfield, Kent Peninsula, and Fury and Hecla Strait (Hørring, 1937: 78); on the (lower) Kazan River (Porsild, in Clarke, 1940: 55); at Somerset Island (Shortt and Peters, 1942: 345); in the Perry River district (Gavin, 1947: 202); and at Boothia Peninsula, Wellington Channel, and Melville Island (Preble, 1908: 272). To the westward and northwestward, there are records from Athabaska, Great Slave, and Great Bear Lakes and Franklin Bay (Preble, 1908: 272); Artillery, Clinton-Colden, and Aylmer Lakes (Preble, 1911: 363); Campbell Lake (Critchell-Bullock, 1931: 13); and Hanbury River (Clarke, 1940: 55).

Columba livia Gmelin, Domestic Pigeon.—An unexpected avian inhabitant of Churchill was the Domestic Pigeon, observed on May 22, 27, and 30 in a flock varying from about 9 to 15 individuals. Mr. Robert Urquhart reported the birds as having been present since the preceding fall.

Bubo virginianus wapacuthu (Gmelin), Arctic Horned Owl.—Fred Schweder, Jr., reported a Horned Owl flying over the Windy River post before sunrise on November 30.

Charles Schweder contributed the following information. During a certain autumn (about 1941) about half a dozen of these owls (with "horns" visible) were observed on the Barrens along the Windy River or between that stream and the upper Kazan River. They came about the first week of October, when the (Willow) Ptarmigan were already white. They were seen chasing Ptarmigan right in the daytime, but not capturing any. While Charles had not actually observed any of the birds in this region at any other time, he had heard owls (presumably of this species) hooting in other years (probably in May) about the "Old Post" on the Red River. The species is obviously not at all common hereabouts.

On March 15, 1948, Charles wrote that his brother Fred had seen a Horned Owl flying southward a month previously.

There are comparatively few records of the Arctic Horned Owl between Nueltin Lake and Hudson Bay: Churchill and near York Factory (Preble, 1902: 110); Taverner and Sutton (1934: 59) also report it at Churchill. To the westward and northwestward, the species is known from Athabaska, Great Slave, and Faber Lakes and Slave, lower Mackenzie, and Bear Rivers (Preble, 1908: 372), and from the junction of the Tazin and Taltson Rivers (Harper, MS).

Nyctea nyctea (Linnaeus), Snowy Owl.—At Churchill one to two Snowy Owls (the first I had ever encountered in the wild) were seen on half a dozen days between May 21 and 31, particularly on the low range of rocky hills east of the town, where they were in the habit of perching on boulders. They were usually rather shy toward pedestrians, taking wing at a considerable distance. They then might pass along a few feet above the ground with steady, measured wingbeats. However, these were rather sophisticated owls; one of them, after retreating to a telephone pole along the highway, allowed a jeep to pass beneath it! On another day one remained on a tripod of telephone poles as a truck passed within 50 yards. Again one perched on a pole at the radio station till I came fairly near. The last one was seen near the Landing Lake.

Although the species nests at Churchill and Cape Churchill (Taverner and Sutton, 1934: 60), it evidently does not do so in the Nueltin Lake region, where it is known only as a winter visitant. Since 1947 seemed to be an "off year" for lemmings, it is not surprising that I saw only a single Snowy Owl during the autumn. It was detected at deep dusk on October 19 as it perched atop a spruce near the shore of Simons' Lake. When stalked, it flew while the would-be collector was still a couple of gunshots distant, and alighted on top of another tree in the delta area where the Windy River enters the lake. Presently a (Willow?) Ptarmigan, perhaps disturbed by the Snowy, was heard cackling in that direction.

Charles Schweder provided the following information. The birds come south in the fall with the early snows—in October or sometimes not till November. They remain throughout the winter, when Charles has seen them (always singly) all the way from Dubawnt Lake to the south end of Nueltin Lake. He may see about one per week; but in different years they vary from many to few. He has never seen a Snowy Owl actually capture a Ptarmigan, but he has frequently seen one in pursuit, and he has observed this sort of prey being eaten. Once a Red Squirrel started to cross an expansion of Little River on the ice; a Snowy Owl dove at it, missing it the first time but capturing it on the next swoop and flying away with it. The species also preys upon Arctic Hares. Apparently it breeds altogether north of the territory Charles is familiar with in summer—as far as the upper Kazan River. On March 15, 1948, he wrote that he had seen no more of these owls during the winter, since our observation of the preceding October 19, but that his brother Fred had seen one a few times in the Windy River area.

Between Nueltin Lake and Hudson Bay the Snowy Owl has been recorded at Churchill and the Churchill River (Preble, 1902: 110), Cape

Churchill (Taverner and Sutton, 1934: 60), Eskimo Point (Hørring, 1937: 102), and the upper Tha-anne River (Porsild, in Clarke, 1940: 55). Manning (1948) evidently found no trace of it at his inland localities in 1945. To the northward, there are records from Southampton Island, Repulse Bay, Cape Fullerton, and Chesterfield (Sutton, 1932: 204), Baker Lake, Wager Inlet, and Melville Peninsula (Hørring, 1937: 102), Yathkyed Lake (Porsild, in Clarke, 1940: 55), the Perry River district (Gavin, 1947: 202), and such localities in the district of Franklin as Melville, Banks, and Victoria Islands (Preble, 1908: 374), Pond Inlet and Prince Regent Inlet (Shortt and Peters, 1942: 346), and Admiralty Inlet (Bray, 1943: 531). To the westward and northwestward, the species is known from Great Slave, Great Bear, and Clinton-Colden Lakes and Anderson River (Preble, 1908: 374), Aylmer Lake (Preble, 1911: 381), Ptarmigan (Casba) River (Critchell-Bullock, 1931: 16), and the Thelon-Hanbury junction (Clarke, 1940: 55).

The A. O. U. Committee on Classification and Nomenclature proposes (*Auk* 61 (3): 450, 1944) to substitute *Nyctea scandiaca* (Linnaeus, 1758: 92) for the time-honored *N. nyctea* (Linnaeus, 1758: 93), thereby concurring in the action of Lönnberg (1931: 306), Mrs. Kelso (1934: 43), and Peters (1940: 125). The sole basis on which this change is advocated is page priority, in entire disregard of Article 28 of the International Rules of Zoological Nomenclature, which states that in the case of two or more synonyms of the same date, the name selected by the first reviser shall stand. It is fairly obvious, from the comprehensive list of references given by Ridgway (1914, 6: 770-772) under *Nyctea nyctea*, that no "first reviser" chose *scandiaca*. Consequently, *Nyctea nyctea* must remain the valid name of the Snowy Owl.

Surnia ulula caparoch (Müller), American Hawk Owl.—Charles Schweder reported seeing a Hawk Owl near the Windy River in the early part of September.

This is apparently one of the distinctly less common birds of the Canadian Northwest. On the west side of Hudson Bay there are records from York Factory and Churchill River (Preble, 1902: 111) and Churchill (Taverner and Sutton, 1934: 61). In the Athabaska-Mackenzie region the bird has been found in a number of localities, including Athabaska, Great Slave, and Great Bear Lakes and Slave, Anderson, and Back Rivers (Preble, 1908: 376), and Aylmer Lake (Preble, 1911: 381). To the southward, Buchanan (1920: 242) collected it at Lac du Brochet.

Asio flammeus flammeus (Pontoppidan), Short-eared Owl.—On June 17 I flushed a Short-eared Owl from the border of a sedge bog near the mouth of Windy River. In deep dusk on August 26 an undetermined owl, but of about the right size for this species, circled low over the Windy River post. After two ineffectual shots, it flew across the river to perch on a rock, where I followed and made two more shots without result. Three times the bird had been attracted near by my "squeaking." On September 28 I flushed a male at the border of a river meadow near camp and secured it. Its bill was fuscous; iris bright lemon yellow; toes grayish olive; nails black; testes 5×3 mm. It was scarcely fat, and weighed 324.6 g. Several subcutaneous worms (identified by John T. Lucker as *Parhamatospiculum bubicola* Skrjabin and

Petrow (Nematoda : Filarioidea)) from the occipital and parietal regions were preserved. On looking at this specimen, Charles Schweder remarked that he had seen a considerable number of the same species during that season, including some as far north as the upper Kazan River.

Between Nueltin Lake and Hudson Bay the Short-eared Owl has been recorded near York Factory, at Churchill, and south of Eskimo Point (Preble, 1902: 109); nesting at Churchill has been described by Taverner and Sutton (1934: 61) and by Grinnell and Palmer (1941: 52). To the northward, it seems to have been reported only at Baker Lake (Clarke, 1940: 55). To the westward and northwestward, there are records at Athabaska, Great Slave, and Great Bear Lakes and Anderson River (Preble, 1908: 367); at Aylmer Lake (Preble, 1911: 379); at Coronation Gulf (Anderson, 1913: 478); at MacKay Lake and near Lac de Gras (Blanchet, 1925: 53); and at Artillery Lake (Clarke, 1940: 55).

Chordeiles minor minor (Forster), Eastern Nighthawk.—Charles Schweder reports the Nighthawk along the Cochrane River, but at no point nearer to Nueltin Lake.

To the eastward, it has been found at York Factory and Churchill (Preble, 1902: 113); to the southward, at Reindeer and Du Brochet Lakes and Cochrane River (Buchanan, 1920: 245), and at Fort Hall Lake (Downes, 1943: 149); to the westward and northwestward, at Athabaska, Great Slave, and Great Bear Lakes, with one record of a straggler on Melville Island (Preble, 1908: 389).

Chaetura pelagica (Linnaeus), Chimney Swift.—Although the Nueltin Lake region lies far out of the normal range of the Chimney Swift, Charles Schweder reports with assurance the presence of two birds about the Windy River post in the summer of 1945 and again in the summer of 1946.

Some of the nearest previous records are from Edmonton, Alberta (Preble, 1908: 390), Indian Head, Saskatchewan, and Winnipeg (Lincoln, in Bent, 1940: 290).

Colaptes auratus borealis Ridgway, Boreal Yellow-shafted Flicker.—On July 1 a Flicker alighted for a few moments, and gave its call, in the top of a tamarack in an extensive spruce thicket near the mouth of Windy River. It then flew on to a similar perch, and presently departed.

On the west side of Hudson Bay the species has been recorded as far north as Churchill (Preble, 1902: 112; Taverner and Sutton, 1934: 52); also inland at Big Sand Lake (Manning, 1948: 16). There is perhaps no previous record for Keewatin. To the westward, the species is known from Athabaska, Great Slave, and Great Bear Lakes and Anderson River (Preble, 1908: 386), Pike's Portage (Preble, 1911: 383), and Fort Enterprise (Clarke, 1940: 56); to the southward, from Cochrane River and Reindeer and Du Brochet Lakes (Buchanan, 1920: 244).

Colaptes cafer collaris Vigors, Red-shafted Flicker.—A Red-shafted Flicker had wandered far out of its normal range to meet its end in some undetermined manner at the uninhabited "Old Post" on Red River. There I found its decomposed body on October 20, lying beside the outer wall of a log building. It had apparently not been dead for many months, and the reddish lining of its wings was conspicuous.

The nearest previous records seem to be from along the route between Edmonton and Athabaska Landing and at Fort Chipewyan (Preble, 1908: 388), on the Slave River (Anderson, 1913: 480), and near Winnipeg (Lincoln, in Bent, 1939: 295).

Picoïdes tridactylus fasciatus Baird, Alaska Three-toed Woodpecker.—On September 22 a Three-toed Woodpecker alighted on a radio pole at the Windy River post, but remained for such a few moments that no conclusion was reached as to which of the two species it represented. It uttered a note sounding vaguely like that of the Red-cockaded Woodpecker. What was possibly the same bird was encountered three days later about ¾ mile farther up the Windy River. It was industriously knocking off chips of bark from a living tamarack stub about 10 feet high, in a thicket of spruce, tamarack, and dwarf birch. In a manner characteristic of members of the genus *Picoïdes*, it accomplished this operation by delivering blows of its bill at a tangent, not at right angles, to the trunk. It had thus denuded a 6-inch-wide area extending about 4 feet vertically on the trunk. There was a similar area on another tamarack stub within a rod or two. The specimen proved to be a female, with a wing of 113 mm. Its maxilla was dark plumbeous; mandible light plumbeous; iris warm brown; tarsus and toes dark slaty. It was scarcely fat and weighed 48 g. Numerous mites (Epidermoptidae?) were collected from it.

The specimen is clearly and amply distinct from a good series of Maine specimens of *P. t. bacatus* Bangs (type locality, Bangor, Maine), especially in the larger amount of white on crown, nape, and wings. In these characters it is practically identical with a topotype of *fasciatus* from Fort Simpson, Mackenzie, and it evidently must be referred to that subspecies, although hitherto *fasciatus* has been generally assumed to range eastward only to western Mackenzie and western Saskatchewan. Ridgway (1914: 291, 295) actually records both forms from Fort Simpson, Fort Anderson, and Great Bear Lake. If such records are authentic, it can only mean that there is very considerable east-west wandering at the non-breeding season; otherwise there must be an astonishing amount of individual variation. Rand (1948b: 41-42) comments on the apparent overlap in distribution of *fasciatus* and *bacatus* that may be explainable by such variation.

According to Charles Schweder, this species (with a speckled back) occurs occasionally in winter along Windy River, and sometimes hammers on poles about the camp. He once saw a Three-toed Woodpecker (sp.?) on the upper Kazan River in winter.

On the west side of Hudson Bay this species of Three-toed Woodpecker has been found as far north as Churchill (Preble, 1902: 112; Taverner and Sutton, 1934: 63) and Sandhill Lake (Manning, 1948: 18). There is apparently no previous record from Keewatin. To the westward and northwestward, it has been recorded from Athabaska, Great Slave, and Great Bear Lakes and Fort Anderson (Preble, 1908: 382), Horton River (Anderson, 1913: 480), and Pike's Portage and McDonald Lake (Clarke, 1940: 56); to the southward, at Brochet on Reindeer Lake (Buchanan, 1920: 243). The Manitoba records (except Buchanan's from Reindeer Lake) have been generally referred to the eastern subspecies; the others, to *fasciatus*.

Eremophila alpestris alpestris (Linnaeus), Northern Horned Lark; *Eremophila alpestris hoyti* (Bishop), Hoyt's Horned Lark.—At Churchill Horned Larks were fairly common and seen almost daily, May 22 to 31, in numbers varying from 1 to 25 or 30. Two subspecies were distinguished. From the 22nd to the 28th birds with white or pale yellowish throats (*hoyti*) seemed to be in the ascendancy; on the 30th some individuals with distinctly yellow throats and sides of head (*alpestris*) were noticed for the first time. The birds fed much upon the garbage or refuse heaps in the town, where they showed an inclination to face into the strong wind. A few were seen on windrows of horse manure and straw along the river shore. Some of them acted pugnaciously toward each other. Some fed in association with, or in proximity to, Snow Buntings. The birds moved ahead with fairly quick steps and rhythmically bobbing heads, pausing at almost every step, or at least every few steps, to pick at something on the ground; meanwhile they raised their heads to look out for possible danger. But such vigilance did not altogether avail them; there was evidence that an occasional individual fell victim to a Domestic Cat.

Up till May 28 I heard very little singing. A bird then sang from the ground, at a distance from me of little more than a rod; its notes sounded sweeter and clearer than my recollection (from years ago) of the Prairie Horned Lark's song. On the 30th a bird with pale yellow throat and sides of head sang from a boulder perch: *chee-cheezly-cheezlit*. At no time during the entire season did I detect a Horned Lark singing from the air. A call-note, uttered in taking wing, sounded something like *tseet-tseet*.

On the Barren Grounds of the Windy River area Horned Larks with practically white or very pale yellow throats (*hoyti*) were rather frequently met with from June 2 to 10, in daily numbers varying from 1 to about 20, including one flock of six or eight (June 6) and another of about 15 (June 7). (The first evidence of their presence came to light on June 1, when the remains of a Horned Lark—obviously the victim of a (Northwestern) Shrike —were found on a willow in a spruce thicket, where feathers had dropped to the ground below.) Lapland Longspurs were associating with them to some extent. At this period the birds were evidently still on migration; in fact, comparatively few seemed to remain to breed. For three months after June 10 Horned Larks were observed on only five occasions; all or nearly all of these had very pale throats. The broad summit of Josie's Hill was apparently preferred as a breeding haunt over the lower country on the north side of the river. Here a bird was singing on a rock on July 2, and two or more were seen on the 12th. Single birds were found on July 3, 4, and 9 on ridges in the Barrens about the mouths of Windy and Little Rivers.

Fred Schweder, Jr., reported small flocks of Horned Larks (presumably *hoyti*) about the mouth of Windy River on September 10?, 14, and 15, and others while he was on a trip to the upper Kazan River, approximately September 17 to 23. Charles Schweder remarked that these birds, like the Snow Buntings and the Lapland Longspurs, are much less common in the Windy River area in the fall than in the spring.

The number recorded in the Nueltin Lake region was roughly 105; these probably included very few "repeats."

An adult female of June 7 is typical *hoyti;* only the middle of the throat, among the light areas of the head, is washed with Sulphur Yellow. The maxilla and the tip of the mandible were fuscous; rest of mandible plumbeous; iris olive-brown; tarsus and toes fuscous; ovary only slightly enlarged. The specimen was fat and weighed 29.7 g.

Between Nueltin Lake and Hudson Bay, Hoyt's Horned Lark has been recorded at York Factory and 50 miles to the northward, Churchill, and 50 miles south of Eskimo Point (Preble, 1902: 114); at Churchill (Taverner and Sutton, 1934: 63); at Eskimo Point (Hørring, 1937: 109); and at Malaher, Boulder, South Henik, Camp, Carr, Alder, Victory, Ninety-seven, and Twin Lakes (Manning, 1948: 18). Farther to the north, the localities include Boothia (Preble, 1908: 398), Southampton Island, Bernard Harbour, Coronation Gulf, Fullerton, Chesterfield, and Tavane (Sutton, 1932: 211), Baker Lake, Repulse Bay, islands at the base of Melville Peninsula, and Kent Peninsula (Hørring, 1937: 109), Somerset Island, Prince Regent Inlet, and Arctic Bay (Shortt and Peters, 1942: 346), and the Perry River district (Gavin, 1947: 202); to the westward and northwestward, Athabaska, Great Slave, and Artillery Lakes, Anderson River, and Liverpool and Franklin Bays (Preble, 1908: 398), Clinton-Colden Lake (Preble, 1911: 385), Sifton Lake (Critchell-Bullock, 1931: 16), and Ptarmigan, Hanbury, and Thelon Rivers (Clarke, 1940: 56); to the southward, Brochet on Reindeer Lake and north thereof (Buchanan, 1920: 246).

The Northern Horned Lark (*E. a. alpestris*) migrates along the west side of Hudson Bay, where it is reported as breeding at Churchill (Taverner and Sutton, 1934: 63). On the other hand, Grinnell and Palmer (1941: 52) consider the breeding birds at Churchill as intermediate between *hoyti* and *alpestris,* though nearer the latter. Sutton (1932: 217) reports *alpestris* as apparently a transient on Southampton Island.

The statement has long been current that *E. a. hoyti* breeds "south to Lake Athabasca" (Oberholser, 1902: 812; Ridgway, 1907: 306), or "south to northern Alberta" (A. O. U. *Check-list,* 1931: 212), or "south to the northern parts of the Prairie Provinces" (Lincoln, in Bent, 1942: 335). In this connection some significant words by Preble (1908: 398) should not be overlooked: "During four summers' work in the north I have never found this bird south of the Barren Grounds during June or July." My own experience during two seasons (1914 and 1920) about Lake Athabaska fully substantiates Preble's statement.

Petrochelidon pyrrhonota (Vieillot) subsp., Cliff Swallow.—Charles Schweder reports a colony of this species on a cliff on the west side of Nueltin Lake, 4 or 5 miles north of The Narrows. He does not meet with the species elsewhere in the region.

On the west side of Hudson Bay, Taverner and Sutton (1934: 64) record two Cliff Swallows seen near Churchill on June 10, 1931. To the westward and northwestward, there are records from Athabaska, Great Slave, Hardisty, Point, and Artillery Lakes and Coppermine, Lockhart, and Anderson Rivers (Preble, 1908: 451), Dease River (Anderson, 1913: 488), and Hanbury and Thelon Rivers (Clarke, 1940: 57); to the southward, from Cochrane River (Buchanan, 1920: 257).

Perisoreus canadensis canadensis (Linné), Canada Jay.—Single Canada Jays were seen on May 20, about 30 miles southwest of Wabowden, and on May 21, a dozen miles north of Herchmer, Manitoba.

During the better part of the summer this old acquaintance of Athabaska days appeared to be all but absent from the Windy River area; I collected a single individual on July 30 in a spruce muskeg. According to Charles Schweder, some Eskimos who had camped at the Windy River post for a couple of months earlier in 1947, had killed off the local birds, using them for dog feed in the lack of caribou meat. Not a single sooty-colored youngster was seen during the season.

When the Caribou returned from the north in August, and their carcasses began to provide sumptuous feasts for various scavengers, the Whisky Jacks lost little time in gathering to take advantage of the situation. From August 20 to December 2 they were recorded on about 43 days—somewhat less than half of the total. They came, however, in very small numbers, generally no more than one or two being seen per day. On only one or two occasions, when attracted to a camp, were as many as three seen together. Most of the single birds were visitors to our camp. When observed off in the "bush," these birds were very apt to be in couples. When one such couple were collected at the fish camp on October 28, they proved to be male and female. When the first one fell, the other came to look into the matter, uttering a peculiar low note. It would be interesting to determine, by further collecting, whether all, or nearly all, winter groups of two are not likewise constituted. It appears at least possible that the birds mate for life.

There were records of approximately 76 individuals in the Nueltin Lake region, but many of these were undoubtedly "repeats."

Aside from our camp area (the most frequent place of observation), spruce tracts, either in muskegs or on upland ridges, were the most favored habitats of the Whisky Jacks. Once a couple were noted in a thicket of willow and dwarf birch. The species appears to be largely dependent on arboreal growth, not venturing appreciably into the Barren Grounds proper. It is one of exceedingly few passerine birds reported to remain at Windy River throughout the winter. It is said by Charles Schweder to be about equally common, winter and summer. Here, as elsewhere, it is a familiar and confiding bird. It would come into the camp dooryard to peck on caribou meat and fat, and now and then it would perch on the cabin roofs. What a contribution it makes to camp life in the North!

It would scarcely be possible to do justice to this bird's vocal versatility. For example, I heard several times, during the latter part of August, a curious mellow trill, suggestive of the call of the Bartramian Sandpiper or that of the Bird-voiced Tree-frog (*Hyla avivoca*). Finally the author was revealed in the form of a Canada Jay, sitting on the tip of a black spruce and preening itself. The note continued to be heard at intervals till mid-November; each trill lasted for perhaps a scant second. In September I heard from a couple of birds in a spruce thicket a *chu-chu-chu-chu-chu-chu,* reminiscent of a Cardinal's *q, q, q;* also a *weeep* note. On another day there was a call that I wrote as *too-doo, too-doo.* At Simons' Lake, on October 19, two birds feeding on a caribou carcass protested my approach: *wuh, ha-ha-ha-ha; wuh, ha-ha-*

ha-ha (each "*a*" with the short sound). The foregoing are mere incomplete samplings of a vocabulary that continually yields surprises.

Fred Schweder, Jr., spoke of noticing Whisky Jacks in winter along the Kazan River 10 miles below Ennadai Lake, where there is a considerable amount of spruce timber, as along the Windy River. He does not find the birds in the intervening Barren Grounds, which apparently do not furnish a requisite amount of arboreal shelter. Charles Schweder reported wintering birds about 30 miles north of Ennadai Lake. On a five-day trip, November 26 to 30, from Windy River southward nearly to the mouth of Putahow River and return, Fred encountered no Whisky Jacks.

Among the Crees of the lower Athabaska River region I found, in 1920, a superstition that the discovery of a nest of this species brings bad luck. Although I was unable to ascertain any similar belief among persons of Cree ancestry in the Nueltin Lake region, it does prevail in the Indian folklore of still other localities, as widely separated as Alaska (Nelson, 1887: 165), Manitoba (Dunlop, 1915: 500), and Ungava (Turner, in Bendire, 1895: 393). Even the Maine woodsmen, according to Mrs. Eckstorm (1902: 113), show an "evident reluctance . . . to hunt up the nests of this bird." It is especially interesting to note that the related European *Perisoreus infaustus infaustus* is likewise considered a bird of ill omen, as reflected in the German common name "Unglückshäher" (Hartert, 1903, 1 (1): 34), in a similar Swedish name (*Ardea* 18: 24, 1929), and in the specific technical name, which signifies "unfortunate."

The Eskimos of the upper Kazan River give to the common bearberry (*Arctostaphylos uva-ursi*) a name signifying "Whisky Jack berry."

An adult male was collected on July 30; an adult female on October 8; and a pair of adults on October 28. The first specimen was in molt; its fresh wing and tail feathers are more broadly tipped with white than the corresponding feathers in the October specimens. The wings of the males measured 139 and 137; of the females, 135 and 131. The males weighed 83.4 (July 30) and 76.1 g. (October 28); the females, 73 (October 8) and 72.2 g. (October 28). The bird of October 8 was slightly fat; those of October 28, scarcely fat. Testes measured 2.5×1.5 (July 30) and 2×1.25 (October 28); the latter were black. An ovary measured 8×3.5 (October 28). In all specimens the bill, tarsus, and toes were black; iris deep olive-brown. In the possession of a dark venter contrasting with a light throat, they agree with typical *P. c. canadensis*.

On the west side of Hudson Bay the Canada Jay has been recorded as far north as Churchill (Preble, 1902: 115; Taverner and Sutton, 1934: 64) and Eyrie and Sandhill Lakes (Manning, 1948: 18). In eastern Mackenzie it has been found on the Thelon River (Critchell-Bullock, 1931: 17; Clarke, 1940; 57). Farther west there are records from numerous localities, including Athabaska, Great Slave, and Great Bear Lakes and Anderson, Horton, and lower Coppermine Rivers (Preble, 1908: 400). To the southward, it is reported by Buchanan (1920: 246) at Reindeer and Du Brochet Lakes. I have noted no previous record for Keewatin.

Pica pica hudsonia (Sabine), American Magpie.—During the winter of 1944-45, according to Charles Schweder, several Magpies appeared in the

Windy River area. One was caught in a trap, and about two were heard in a spruce tract 2 miles west of the river's mouth. This was part of an eruptive movement far beyond the normal range of the species.

Until recently, some of the nearest previous records were at York Factory (Preble, 1902: 114), the Athabaska River near McMurray (Preble, 1908: 400), "the Mackenzie country" (Taverner, 1926: 255), and Brochet on Reindeer Lake (Lincoln, in Bent, 1947: 154). Rand (1949: 178) discusses the northeastern spread of the Magpie during the past few years, presenting records from Herb Lake, the Nejaniline Lake district, 50 miles west of Churchill, the Cape Churchill district, and Pikwitonie (Mile 213, Hudson Bay Railway).

Corvus corax principalis Ridgway, Northern Raven.—The name of this species among the upper Kazan River Eskimos is something like *Aquoila*.

In the Windy River area the Raven is resident in small numbers and was observed at fairly frequent intervals from June 4 to December 3. During July, August, and September these intervals averaged approximately a week, though one stretched from July 26 to August 22. In June I noted the species on 12 days, in October on 20 days, and in November on 22 days. Single birds were seen more frequently than several together; but twos were not uncommon. Larger numbers in bands were noted as follows: three on June 30, November 1 and 14; three or four on October 20; four on June 26, September 12, October 1 and 31; six on October 8; eight on October 15; and fourteen on October 21. Thus all the larger congregations seemed to occur in October. Most of the observations were made about the mouth of Windy River; a few at Josie's Bay (July), and at Simons' Lake (October). The reappearance of the birds on August 22, after not being seen for nearly a month, is suggestively similar to the Canada Jay's arrival in the vicinity of our camp on August 20; both cases may have been correlated with the general availability of caribou bodies to feed upon from that time onward. An interesting question is: Where had the birds been during the preceding month?

The individuals I recorded in the Nueltin Lake region numbered approximately 171, but these must have included many "repeats."

The Raven population on the Barren Grounds is apparently rather thinly distributed, with only slight concentrations in certain favorable localities, such as trap-lines or the vicinity of camps, where considerable numbers of caribou bodies may be found. Although it is such a characteristic and well-known bird of the Barrens, it is a little surprising to note that actual records of its occurrence are none too frequent in the journals of various explorers (*cf.* Preble, 1902: 115; Clarke, 1940: 57).

The great majority of the Ravens observed were on the wing, passing from one point to another. I made note of only about four occasions when a solitary bird was seen to alight on a ridge in the Barrens; at another time, in October, a few tracks were found in the snow on such a ridge. I do not recall a single instance of perching on a tree or a cliff. Though generally pursuing a more or less direct flight, the birds were observed circling on a number of occasions—always in bands of two or three to eight individuals. Four birds circling and calling over the "Pile o' Rocks" on June 26 contributed a distinct bit of life and sound to the wild and lonely Barrens. This was the

first date on which I recorded any of the birds in company; it was possibly not too early in the season for the young ones to have joined their parents in flight. In the same area, on the 30th, three Ravens gyrated several hundred feet overhead, whence sounded now and then a sepulchral *garrh, garrh, garrh.* Two of the birds maintained for the most part a very close, wing-and wing formation, while the third merely stayed in their vicinity. Their flapping was interspersed with occasional sailing. The only motive for these maneuvers may have been simple enjoyment. Again on October 1 a flock of four was sailing in this favorite haunt and giving a hollow rattle—*k-r-r-r-r-k.* The *whiff-whiff* of their wings was heard several times at a height of only 40-50 feet. On October 8 six birds passed westward, high above Windy River, meanwhile circling and maintaining a formation of twos within the flock. At Simons' Lake, on Ocotber 15, a flock of eight circled while passing southward at a height of about 300 feet; they croaked *kr-a-a-h, kr-a-a-h,* and also uttered a bell-like *tok-tok-tok.* (For a description of the gyrating antics of several Ravens with a Goshawk on October 31, see the account of the latter species.) On November 1 two or three Ravens persisted in circling right above me, within easy range. In addition to the croaking *k-r-r-a-a-h,* one gave a sort of liquid gurgle; and still other notes from their varied vocabulary were loosened on the frosty air.

The vocal performances mentioned above have been set down as originally entered in my field notes. Possibly there is more variation in some of these representations than in the corresponding calls; yet there is plenty of variation in the calls themselves! Probably the commonest note heard was a guttural, croaking *kr-r-a-a-h;* it was occasionally repeated in a series of two to four notes. This ordinarily unemotional flight-note is given with extra emphasis on occasion; for example, at Simons' Lake on October 18 a sudden, raucous *kr-a-a-a-h* signalized a passing Raven's alarm at catching sight of me directly below it in a spruce thicket. (I was quite startled, too, at this cry out of the blue.) By that time of year the Barrens had become a rather silent land, with few sounds of life except occasionally a Raven's croak or a Ptarmigan's cackle. A variant call heard on October 31 was a very coarse *gurrk, gurrk.* The bell-like note of October 15 was heard again at Simons' Lake four days later. The liquid gurgle noted on November 1 was uttered repeatedly by a bird on November 30 as it flapped up and down on a rocky summit near Windy River. On June 16 a passing Raven hollered a sepulchral *gralloch, gralloch;* the same note was heard again in October. After November 4 a comparative silence seemed to fall upon the Ravens in the bleak, snowy landscape; as far as my notes indicate, it was broken only twice in the following month.

During the summer most of the birds appeared quite wary, keeping at a respectful distance from any human being. Later on they appeared to discard much of their wariness; this may have been due. in some measure, to the presence of inexperienced birds of the year. As Freuchen remarks (in Hørring, 1937: 108), "The young Ravens are far more confident than the old ones." Early in the morning of August 24 one came sailing and croaking over our camp, passing only about 20 feet above me. It alighted farther up the rocky shore of the river, and presently flew to the top of a knoll where

some caribou hides were pegged out to dry. Once more it flew toward camp within easy range, and thus became a specimen. On September 19 another specimen came to hand through the bird's deliberately flying within a short distance. Along Windy River, on October 13 and again on the 25th, a Raven passed 50 feet overhead. On October 31 two others invited themselves into my collection by acting similarly; at that season some of the birds simply persisted in flying directly overhead as I would pass along a ridge near camp.

At Simons' Lake on October 21 a loose flock of about 14 Ravens (the largest noted during the season) passed northeastward, giving the usual flight note. After sundown on November 14 two single birds, followed by a band of three, winged steadily and silently west-southwestward past the mouth of Windy River, perhaps bent on gaining some habitual roosting-place, such as a cliff. In general, the species seems to vary its course through the air with considerably more sailing than the Crow does.

Charles Schweder speaks as if ordinarily the Ravens, for the most part, leave the Windy River area after November, and return in April or May, perhaps with the Caribou. He has frequently seen the birds following Foxes and Wolves, as if (at least in the case of the latter animals) in expectation of a kill. The more Caribou, he says, the more Ravens are seen. On November 2 I saw a distant bird (doubtless a Raven) beyond Little River, flying approximately toward the spot where a Wolf was howling; evidently the presence of this animal meant some possible scraps of food for the avian scavenger. Buchanan remarks (1920: 248) concerning the country to the southward, that the "birds appear to remain in the vicinity of the Caribou herds all th[r]ough winter."

The gizzard of a Raven collected on September 19 was crammed with caribou hair, a pebble, and several berries (*Vaccinium*?). The proventriculus and gizzard of another, October 31, was filled with caribou hair and meat.

Perhaps a hundred Ravens had been caught in Charles Schweder's fox traps over a period of years. So many of the birds thus become victims as to account for much of the depletion in their numbers during the winter. If, as is probable, this state of affairs prevails on the long trap-lines extending over the Barren Grounds generally, it may have a fairly serious effect on the Raven population as a whole. Foxes (probably of the smaller species as well as the larger) will eat the trapped Ravens.

Once in May Charles was driving his dogteam over the ice of Windy Lake when two Ravens flew up, at a point a mile from shore. There he found a Spruce Partridge, still warm and bloody, with its feathers scattered about. He could not make out what had killed this bird, unless it was the Ravens. It was particularly strange to find it so far from shore, unless its attackers had chased it there.

Mallophaga from two of the specimens were determined as follows: *Myrsidea* sp. (August 24 and September 19) and *Philopterus* sp. (September 19).

Four Ravens were preserved: a female (August 24) and three males (one on September 19, two on October 31). (The first two were inadvertently left behind at field headquarters, but subsequently reached the National Museum of Canada.) As far as may be judged by the complete granula-

tion of the skulls, all are adult; furthermore, the two specimens at hand have the elongate throat feathers and the general glossy plumage of adults. The wings of two males measure 411 and 429; exposed culmens, 75 and 74. Approximate weights were as follows: female, quite fat, 2½ lbs.; male, September 19, somewhat fat, 2¾ lbs.; male, October 31, excessively fat, 3¼ lbs.; male, October 31, very fat, 3 lbs. The heaviest specimen had fat a quarter of an inch thick, concentrated mainly beneath the feather tracts—a fine insulation against the Arctic cold, resulting doubtless from long-sustained feasting on caribou carcasses. The ovary of the female was very small. Testes measured as follows: about 4×2.5, September 19; 5×2.5 (not pigmented) and 4×2.25 (brown), October 31. In all specimens the bill, tarsus, toes, and nails were black (extreme tip of the bill horn color in one male); iris dark grayish olive (female) to olive-brown (males).

This widely occurring though not very common bird figures in practically all accounts of exploration in the Barren Grounds. Preble (1902: 115) records it at Churchill, where it is rated by Taverner and Sutton (1934: 65) as a not common permanent resident. Manning (1948: 18) reports it at only two of the 19 localities he investigated in 1945: Sandhill and Boulder Lakes. It is found the year round on Southampton Island (Sutton, 1932: 219), and ranges north to Melville and Beechey Islands (Preble, 1908: 403). Hørring (1937: 104) mentions numerous localities, from Lancaster Sound in the north to Eskimo Point in the south. Gavin (1947: 203) found the Raven in the Perry River district only in winter. Among the localities to the westward and northwestward given by Preble (1908: 403) are Athabaska, Great Slave, Great Bear, and Artillery Lakes and Anderson and Lockhart Rivers; to these Preble (1911: 386) adds Aylmer Lake. In the Artillery Lake region Critchell-Bullock (1931: 17) found it absent during the winter from October 20 to February 21. Clarke (1940: 57) gives records for Hanbury, Thelon, and (lower) Kazan Rivers. Buchanan (1920: 247) found the Raven at Reindeer, Du Brochet, and Kasmere (Theitaga) Lakes; Downes (1943: 97, 149), at Cochrane River and Fort Hall Lake.

Corvus brachyrhynchos brachyrhynchos Brehm, Eastern Crow.—On June 15 a black bird of about the right size for a Crow, and cawing like one, flew across the Windy River above its mouth. However, a Raven flew to join it, and I was so little prepared to find a Crow in this area that I was inclined at the time to consider the first bird also a Raven with an aberrant note. But Charles Schweder was on the far side of the river, where he obtained a much closer view of the bird, and he assured me later that it was a Crow. The species did not come to my notice again during the season.

Between Nueltin Lake and Hudson Bay, the Crow has been recorded by Preble (1902: 116) at York Factory, Churchill, and 50 miles south of Eskimo Point, and again at Churchill by Taverner and Sutton (1934: 65). To the westward, it has been found on the Athabaska, Slave, and Grandin Rivers and Great Slave Lake (Preble, 1908: 406), and at Artillery Lake (Clarke, 1940: 57); to the southward, at Reindeer and Du Brochet Lakes and Cochrane River (Buchanan, 1920: 248).

Turdus migratorius migratorius Linné, Eastern Robin.—A Robin was heard singing on May 20 at Wabowden, Manitoba. On the same date, but a year

later, the first bird of the season made its appearance at Churchill (R. D. Lawton, *in litt.*).

At Windy River it was not until June 3, three days after my own arrival, that the first Robin was heard. Thereafter, until August 17, the species was noted in very small numbers, but freqeuntly: on 20 days in June, 24 days in July, and 7 days in August. Several of the July records were from Josie's Bay, where single birds were noted from the 11th to the 17th. In general, no more than three or four birds were recorded per day; frequently there was only one. During June the birds appeared chiefly in tracts of spruce (probably more on the uplands than in the muskegs); several times they were seen on the Barrens; and on June 9 two were foraging in a wet sedge bog. During the last week of the month a few came into the camp dooryard. In July and the first part of August there were more records in the dooryard than in all other habitats combined; among the latter, spruce tracts were preferred. Although previous experience had led me to regard Robins in the Athabaska and Great Slave Lakes region as rather shy birds of the wilderness, here at camp they showed a familiarity approaching that in the settled communities of the Eastern United States. The first speckled fledgling was noted on July 20; another was following a parent on the 28th; and another was seen on August 8.

For a period of nearly four weeks after August 17 there was a hiatus in observations. Perhaps the local breeding birds and their offspring had departed for the season, although there is a possibility that they had merely gone into seclusion for the period of molt. On September 12 Robins reappeared in larger numbers than previously. Fred Schweder, Jr., then reported about 50 individuals, in groups of five or six, among rocky hills on the south side of Windy River. On the opposite side, on the same day, Charles Schweder noted one bird in the speckled juvenal plumage. On the next day I saw a loose flock of about five on the south side of the river. Single birds were noted on the 19th and 24th. On the 25th I collected two birds (one of them from a flock of several) in thickets of dwarf birch, alder, and spruce along the river. These autumn birds were distinctly wild, and it was difficult to approach them within ordinary range. On October 4 Fred Schweder, Jr., and Charles Schweder reported about 14 birds up the river toward Four-hill Creek. On October 5 and 6 about 6 inches of snow fell, covering the ground that had been largely bare for ten days previously. The berries, such as *Empetrum, Vaccinium vitis-idaea,* and *V. uliginosum,* on which the Robins had presumably been depending for sustenance, now became inaccessible, and no more of the birds were seen. The mouth of a specimen of September 25 was stained black, as with *Empetrum* berries. It is perhaps significant that none of the September and October birds seemed to come into the camp dooryard; if they had been the same individuals as those present during the summer, they might have been expected to continue to resort thither.

I recorded approximately 166 birds (among them doubtless many "repeats") in the Nueltin Lake region.

The song season seemed to extend only from June 9 to July 17. The brevity of this season suggests that only a single brood is reared on the borders of the Barrens.

According to Charles Schweder, most of the local Robins nest in trees, but some on the ground. He has found the nests in open bogs and in grassy places. One at the "Old Post" was on bare ground, though timber growth was all about. Sometimes the birds build in willows.

Charles once saw a few Robins in October on the Kazan River 15 miles below Ennadai Lake. Apparently the country between the Windy and Kazan Rivers contains too little timber to be a very favorable haunt for the species.

Three specimens in first winter plumage were obtained: two males, September 25 and October 4, and one female, September 25. The skull in each is only partly granulated. Though varying slightly in some minor details from average *T. m. migratorius* of similar age from the Eastern United States, they are referable to that subspecies. The crown feathers are black, edged with Deep Olive (more broadly in the female than in the males); back Deep Olive; entire width of throat streaked with black in males, but only sides of throat streaked with dusky in female; sides of throat (or entire throat in one male) with a pale suffusion of the breast color, which varies from Tawny in the males to Ochraceous-Tawny in the female; feathers of upper breast more broadly tipped with Deep Olive-Gray and those of lower breast and belly more broadly tipped with white than in average specimens; under tail-coverts well streaked with Dark Neutral Gray. Length of specimens in the flesh, 245 (male) to 254 (female); wing, 126, 130 (males), 127 (female); testes, 2.5×1.5 and 2×1; weight of one male, 93.8, of female, 90.4 g. The males were excessively fat; the female, very fat. In one male the thickness of the fat over the belly was 8 mm. Bill black or fuscous; mandibular tomia pale or greenish; base of mandible (in one male) skin color; iris deep, warm brown; tarsus and toes fuscous.

Each of two specimens of September 25 yielded a mallophagan, *Brüelia cedrorum*.

On the west side of Hudson Bay the Robin has been found breeding as far north as Churchill (Preble, 1902: 130; Taverner and Sutton, 1934: 66); and in the hinterland, still farther north at Malaher, Boulder, and South Henik Lakes and Tha-anne River (Manning, 1948: 18). (These last were apparently the first records for Keewatin.) There are records from numerous localities in the Athabaska-Mackenzie region, including Athabaska, Great Slave, and Great Bear Lakes and Anderson, Horton, Coppermine, and Thelon Rivers (Preble, 1908: 495); also Artillery Lake (Preble, 1911: 404), Dease River and Coronation Gulf (Anderson, 1913: 493), and Ptarmigan Lake (Clarke, 1940: 58). To the southward, Buchanan (1920: 263) found Robins at Reindeer Lake and Cochrane River; Downes (1943: 149), at Fort Hall Lake. Thus the species pushes northward well beyond the southernmost extensions of the Barren Grounds, but rarely (as at Coronation Gulf and the Mackenzie Delta) beyond the northernmost outposts of timber.

Hylocichla minima minima (Lafresnaye), Northern Gray-cheeked Thrush.—This is the only representative of its genus along the Windy River, where it was one of the later avian arrivals in 1947. From June 9 to September 3 it was present in comparatively small numbers. Meanwhile never more than three or four days in succession passed by without an observation. The maximum number noted during any day was approximately half a dozen; on many

days no more than one or two were seen or heard. At Josie's Bay, July 10 to 18, the status of the species was practically the same as at Windy River. The number recorded during the season was about 108; this must have included a good many "repeats."

Of natural habitats, the upland thickets of spruce and tamarack seem to constitute the one *par excellence*. The species was found to a far less extent on the river bluffs, where dwarf birch is the predominant growth, and in the muskegs of spruce and tamarack. Occasionally it was noted on the Barrens, and once in burned-over spruce woods. On the other hand, it resorted to the man-made habitat of the camp dooryard to such an extent that it was actually recorded there more frequently than in the spruce tracts. One of its first appearances about the camp was on June 27 (a day of sleety snow), but it came only a few times during the next month. From July 27 to August 29, however, it was recorded in the dooryard on 23 days, and quite infrequently anywhere else. Probably it was attracted by a variety of insect life to be found among the wood chips, caribou bones, and other refuse of the camp. One day a bird wandered into a storehouse through the open door. G. J. Wallace suggests (1939: 294) in the case of Bicknell's Thrush (*H. m. bicknelli*) that it is the female that is "found feeding fearlessly about cabins after the nesting cares are over." It is thus particularly interesting to note that the Graycheeks resorted to the Windy River camp chiefly at the period indicated by Wallace; further, that the one adult and the one juvenile taken there were females. The last individual was seen on September 3, in a muskeg.

Although Brewster (1906: 386) attributes to the Graycheek a "dislike of strong sunlight" in its haunts as a migrant, it has little chance of escape from highly actinic rays during the long summer days on the borders of the Barrens. It apparently did not hesitate to leave the slight shade of the stunted spruces for the open camp area at practically any time of day. Here it did not become quite so familiar as the Robin, and in the "bush" it was so retiring that observation was by no means easy.

At Josie's Bay, during the evening hours of July 12, a Graycheek came out on an upland ridge in the Barrens, hopping about on small boulders and on the ground. It exhibited a habit of flirting its wings in a jerky manner, reminiscent of the Mockingbird's trick of half opening its wings. This may have been indulged in just before the bird would hop off a little way. Meanwhile it called a number of times.

The first song was heard on June 11; the last, on July 29. During the last days of this period, the singing seemed to decline in vigor and persistence. Thereafter even call-notes were heard infrequently—on August 1, 2, 8, and 29 and September 1. On June 15 a Graycheek followed a Fox Sparrow by a few minutes in taking almost the same singing perch close to the top of a 40-foot tamarack in an upland thicket composed mainly of shorter black spruces; it then sang a few phrases. Presently the same or another Graycheek took a position on the top of a 12-foot spruce in this thicket, but delivered such a subdued song that it was difficult to distinguish the separate notes at 18-20 yards. On June 20 a bird on the above-mentioned tamarack gave a burry call-note—*wheéur, wheéur*. The next morning a Graycheek sang within a rod of my station in a thicket of spruce and dwarf birch on a bluff at the mouth

of Windy River, where I was filming Caribou on the opposite side. The song was decidedly Veerylike in quality—something like *reeerh-reeerh, reeerh-reeerh*. This might be compared with my rendering of the song of Bicknell's Thrush in the balsam and spruce scrub below the Lake of the Clouds on Mount Washington, N. H., on June 28, 1928: *kreer'-reer'; queer-reé*. The last bird I heard in full song was perching on a spruce tip in a muskeg in the twilight of July 23.

The apparent ending of the Graycheek's song season on July 29 may be compared with the last dates on which I recorded the song of two other species of *Hylocichla* in 1914 (along the Tazin River) and in 1920 (on Lake Athabaska): Hermit Thrush, July 17, 1914, and July 25, 1920; Olive-backed Thrush, July 14, 1914, and July 16, 1920. The earlier beginning of the breeding season in these last two localities evidently results in an earlier cessation of song at the close of the breeding season in July. There is obviously only one brood per year in these latitudes.

The last hour at the end of the Arctic summer day, when most of the other birds had hushed for a brief nocturnal rest, belonged particularly to the Gray-cheeked Thrush. Nearly every evening, as I retired to my solitary tent among the spruces on a ridge overlooking the river, one of these birds would be pouring out its twilight song. It was a rare privilege to be the nightly beneficiary of such a lullaby. Not that the bird ranks highly among its fellow-members of the genus *Hylocichla*. It can scarcely begin to compare with that divine singer, the Hermit, or even the Oliveback; and although the song is decidedly Veerylike in quality, it seems to lack the fervor of that bird's performance. Only rarely did I actually see one of the birds in song; for the most part it was just a voice at a distance among the spruces. Evidently the song did not continue through the night, like the winnowing of the Wilson's Snipe sweeping about overhead.

The call-note commonly heard sounded like *peéur* or *wheéur*. On one occasion another was heard—a shorter *tyool*.

The first individual in the spotted juvenal plumage appeared in the dooryard on July 28; it was already exhibiting the characteristic wing-flirt of its species. From August 3 to 17 few except juvenile birds appeared in the vicinity. The youngsters seemed much more confiding than the adults; one came fearlessly within 10-12 feet of me. The small number of birds noted from August 20 to September 3 were not determined as to age. It appeared possible, however, that the bulk of the adults had migrated southward in advance of the immatures.

Four specimens were preserved: two adult females, July 22 and August 1, a juvenile female, August 3, and a juvenile male (with tail only half grown), August 4. The first adult was collected on an island in Windy Bay; the other three specimens, near the mouth of Windy River. The adult females (inadvertently taken in mouse traps) had reduced ovaries and bare brood patches; bill fuscous; basal part of mandible yellowish brown or horn color; tomia (in part) and commissure yellow (noted in one specimen); iris very dark brown or deep olive-brown; tarsus dark brown or grayish brown; toes fuscous or grayish brown; weight, 29.1 and 32.9 g. In the juvenile specimens the bill was fuscous; mandible partly or wholly horn color; tomia

and commissure yellow (noted in male); iris dark olive or dark olive-brown; tarsus and toes brownish gray; weight 29.4 (male) and 32.3 g. (female). The two adult females (both in worn breeding plumage) have distinctly different coloration of the upper parts—between Deep Grayish Olive and Hair Brown (July 22) and Brownish Olive (August 1).

Charles Schweder has noted some Graycheeks on the upper Kazan River below Ennadai Lake.

Along the western coast of Hudson Bay the species nests as far north as Churchill (Preble, 1902: 129; Taverner and Sutton, 1934: 66). Farther inland Manning (1948: 19) found it at Sandhill, Malaher, Boulder, and South Henik Lakes and Tha-anne River. In the Athabaska-Mackenzie region Preble (1908: 491) records it from Great Slave and Artillery Lakes nearly to Great Bear Lake and on the Anderson and Horton Rivers. In July, 1914, I found the Graycheek at Hill Island Lake. Buchanan (1920: 73, 263) collected a specimen on June 18 along the Churchill River north of Lac la Ronge—evidently very close to the southern boundary of its breeding range. The northern limits of the Graycheek seem to correspond almost exactly to those of the Robin. Its southern breeding limits coincide rather closely with those of the Tree Sparrow, both being at the southern edge of the Hudsonian Zone.

Anthus rubescens rubescens (Tunstall), American Pipit.—On June 5 several Pipits appeared at a sedge bog near the mouth of Windy River, where the surface had melted sufficiently to permit feeding by a few shore birds and ducks. It was not until six days later that two or three more were seen on the river shore and the hilly Barrens. Thereafter no more Pipits were seen till June 25, when two or more began frequenting the camp dooryard and continued till July 3. Inclement weather during this period may have reduced the supply of insects generally available and caused the birds to resort to the favorable feeding-ground in the dooryard. Apparently those that became established for the summer nested for the most part on the higher rocky hills on the south side of the river; comparatively few birds were seen in the lower country on the north side during the period while the young were under the parents' care. Those that came to the dooryard in the meantime may have flown from nesting grounds across the river. Here a bird might be seen walking about with mincing steps, bobbing its head with each step and tilting its tail with vigor. Even when not moving ahead, it would keep its tail gently tilting.

On July 16 two Pipits were found on the hilltop Barrens on the north side of Josie's Bay and about 200 feet above it. They were foraging over this rocky and gravelly terrain, gathering billfuls of food. I sat quietly for probably three-quarters of an hour, in the vain hope that they would reveal the location of nest or fledglings. They advanced over the ground with active steps, accompanied by the usual head-bobbing and tail-tilting. It was amazing to see a billful (presumably of insects) grow until it was at least half the size of the bird's head. Apparently none of the material was lost as additional bits were picked up. Once or twice, however, the bird may have deliberately laid its load down to make a series of pecks at some food; I could not be quite sure.

During the entire season I heard no song from the Pipit, and scarcely even a call-note until July 29. I then found an adult female on a boulder-studded slope on the south side of Windy River. For the most part it perched on boulders, twitching its tail vertically while giving an anxious note—*sit, sit, sit,* etc.—at intervals of approximately 1 second. Perhaps twice it perched on the tiptop of a small spruce. Presently I heard from it the usual call of the migration period, a sharp, rapid, four-syllabled *cheet-cheet-cheet-cheet* (which is uttered mainly on the wing). During the next two months it was only infrequently that I recorded any call-note; most of the birds that came under observation seemed to remain silent.

The first two juvenile birds were noted on August 4 and 5, in each case in company with an adult. Others in this plumage were distinguished on the 8th, 9th, 12th, and possibly the 29th.

On August 5, after an interval of more than a month, Pipits began once more to frequent the camp dooryard and the adjacent river shore, and so continued till September 28. Occasionally one would perch on the roof of a log cabin. During this period none were recorded between September 13 and 24, but otherwise they appeared in the camp area very nearly every day. Meanwhile extremely few were observed elsewhere on the Barrens. The maximum daily number recorded in August and September was three or four, and some of these were very likely "repeats."

On August 12 a juvenile bird was pecking at blowflies on fish on the river shore and captured at least one of them. It thus came within 8 or 10 feet of several persons. The next day a Pipit kept coming right under the nose of a Husky dog, within 15 inches of its paw. While the dog noticed the bird, it made no predatory move. On the 14th I filmed a Pipit at a distance of 5 to 8 feet, close to the feet of another Husky dog. On August 29 an apparently immature bird walked over some drying caribou meat on a stone a couple of yards in front of the cabin door, made a short winged sally to capture a fly, and walked to within a yard of me. The last bird of the season was reported by Charles Schweder on September 30. By the third week of September the more advanced migrants (adults?) have reached the northern parts of the United States.

The individuals recorded during the season, including "repeats," numbered about 106.

A mallophagan, *Philopterus subflavescens*, was obtained from a specimen of August 4. A parasitic worm was found on the neck of an adult male, June 11; the preserved material "appears to be part of a large female nematode . . . and is considered unidentifiable," according to John T. Lucker, of the Bureau of Animal Industry.

Among seven specimens collected, two adult males (June 5 and 11) have the Cinnamon-Buff under parts (with lighter streaking) and the Pinkish Buff superciliary stripe that are presumably characteristic of the third or later summers (*cf.* Ridgway, 1904: 12-13). One adult male (June 25) and two adult females (July 29 and August 6) have the Light Ochraceous-Buff under parts (with heavier streaking) and the Light Buff superciliary stripe that are presumably characteristic of the second summer; in this group the crown is a little more distinctly streaked, and the plumage in general is more worn, than

in the first-mentioned group. Taverner and Sutton remark (1934: 68): "It is still uncertain just what these two very distinct plumages represent." It is perhaps significant that the brighter colored specimens in both their collection and mine were taken not later than June 12. A male (August 4) and a female (August 5) are in the "first" (*i. e.*, juvenal) plumage described by Ridgway (1904: 13); however, the Light Buff superciliary stripe is not indistinct or obsolete. The adult females had bare brood patches. In adults the bill is fuscous (or black in two males); base of mandible horn color in females; iris deep olive-brown; tarsus and toes fuscous or black in males, (dark) grayish brown in females. In the two juvenile birds the bill is fuscous (or dark brown in female); base of mandible horn color in female; iris dark olive (female); tarsus and toes pale brownish. Weight: three adult males (slightly to excessively fat), 24.4, 22.4, and 19.1 g.; two adult females (slightly fat), 19.1 and 18.4 g.; juvenile male, 21.7 g.; juvenile female (slightly fat), 27.6 g. Testes of three adult males, 8×4.5, 8.5×6, and 10×6. The skull was not granulated in the two juvenile birds.

The Pipit is widely distributed on the Barren Grounds in summer: Churchill (Preble, 1902: 128; Taverner and Sutton, 1934: 68); Chesterfield, Tavane, and Eskimo Point (Sutton, 1931: 159); Southampton Island and Fullerton (Sutton, 1932: 223); Danish Island (Hørring, 1937: 112); Somerset Island, Arctic Bay, and Pond Inlet (Shortt and Peters, 1942: 347); Melville Peninsula (Bray, 1943: 532); Sandhill, Malaher, South Henik, Camp, Carr, Alder, Victory, Ninety-seven, and Twin Lakes (Manning, 1948: 19); Anderson River region (Preble, 1908: 481); Great Slave, Artillery, Aylmer, and Clinton-Colden Lakes (Preble, 1911: 402); Franklin Bay and Coronation Gulf (Anderson, 1913: 491); Thelon River (Critchell-Bullock, 1931: 18); Hanbury River and Aberdeen, Schultz, and Baker Lakes (Clarke, 1940: 58).

A little experience with the European Water-pipit (*A. s. spinoletta* (Linnaeus)) in the Pyrenees in 1919 made me quite skeptical as to its being conspecific with the American Pipit. Differences in habitus and voice as well as in plumage are evidently greater than should be expected in birds subspecifically related. Moreover, Swarth (1931: 161) has expressed the "conviction" that the Asiatic *japonicus* and the American *rubescens* "should be regarded as distinct species." I am in cordial agreement with Todd (1935: 63) in restoring to the American Pipit its specific designation of former years.

Lanius excubitor invictus Grinnell, Northwestern Shrike.—A Shrike had evidently been near the mouth of Windy River on June 1 (or shortly before), for on that date I found the remains of a Horned Lark left on a willow in a spruce thicket, with some of the feathers fallen to the ground below. On September 1 a Shrike was seen in a burned and cut-over spruce tract; two days later one perched briefly on a radio pole at the Windy River post, and indulged slightly in song. The circumstances of these observations did not enable me to make even a specific determination; but presumably the subspecies named above was the one involved.

Fred Schweder, Jr., spoke of generally seeing three or four Shrikes in the Windy River area in the course of a year. In August, 1944, he found an adult, with four young ones able to fly, on an island in Windy Bay. He has

seen other Shrikes in July, mostly west of the Windy River post; he also reported one in August, 1947.

On the west side of Hudson Bay, *Lanius excubitor* subsp. has been reported at York Factory and Churchill by Preble (1902: 124), and again at Churchill by Taverner and Sutton (1934: 69) and Allen (1946: 332, pl. 12); in the Mackenzie region, at Great Slave and Great Bear Lakes and Anderson River (Preble, 1908: 459); and to the southward, at Cochrane River (Buchanan, 1920: 259). The A. O. U. *Check-list* (1931: 272) and Miller (1931: 53) include northern Alberta and Saskatchewan in the breeding range of *L. b. invictus*, on apparently dubious grounds.

Dendroica coronata coronata (Linné), Eastern Myrtle Warbler.—This species occurs rather sparingly about the mouth of Windy River, where single birds were seen on June 11 and 13 and July 30—each one among spruces.

Between Nueltin Lake and Hudson Bay, the Myrtle Warbler has been found at Churchill (Preble, 1902: 126; Taverner and Sutton, 1934: 70) and at Neck and Sandhill Lakes (Manning, 1948: 19); to the northeast, at Southampton Island (one record—Sutton, 1932: 225); to the westward and northwestward, at Athabaska, Great Slave, and Artillery Lakes and Anderson River (Preble, 1908: 470); and to the southward, at Reindeer and Du Brochet Lakes and Cochrane River (Buchanan, 1920: 260).

Dendroica striata lurida Burleigh and Peters, Western Blackpoll Warbler.—The Blackpoll summers in small numbers along the Windy River and at Josie's Bay. The first arrival was noted on June 11; the last autumn lingerer, on September 10. Meanwhile I recorded the species on six days in June, eight days in July, four days in August, and two days in September. Several of these observations (July 11 to 18) were at Josie's Bay. For the most part no more than one bird was seen per day; but twice or thrice there were two. The individuals recorded during the season numbered about 23.

A majority of the birds were found in tracts of spruce, either on upland ridges or in muskegs. Several of them came into the camp dooryard, and a few were seen among dwarf birches or other shrubbery near the river.

On June 15 two males in a spruce muskeg were chasing each other with spirit; doubtless they were contending for breeding territory. On July 29 a pair in an upland spruce thicket were carrying food in their bills. By August 21 an adult male was molting into winter plumage. The few birds seen thereafter, August 23 to September 10, were all in immature or winter plumage. The song was heard definitely on only a few occasions, July 4 to 18. A call-note, *tsit*, was recorded only on September 2.

An adult male taken on June 11 was rather fat and weighed 13.4 g.; testes 5.5×5.5; maxilla fuscous; mandible plumbeous, yellowish basally; iris olive-brown; tarsus pale yellowish brown; toes dull brownish yellow. The black feathers of the pileum, in worn summer plumage, have little gloss, and most of them are lightly tipped with Dull Citrine. The posterior border of the pileum is not so sharply defined as in full-plumaged eastern males. The light area of the back is Olive-Gray. The back and under parts are less heavily streaked than those of the average eastern male. On the whole, the specimen seems referable to *D. s. lurida* Burligh and Peters (1948: 119).

The Blackpoll breeds on the west coast of Hudson Bay north to Churchill

(Preble, 1902: 126; Taverner and Sutton, 1934: 70); inland, at Big Sand, Neck, Sandhill, and Boulder Lakes and Tha-anne River (Manning, 1948: 20). In the Athabaska-Mackenzie region it has been recorded at Athabaska, Great Slave, Great Bear, and Artillery Lakes and Anderson River (Preble, 1908: 473); and on the Thelon and Hanbury Rivers (Clarke, 1940: 59). To the southward, Buchanan (1920: 261) found it at Reindeer and Du Brochet Lakes and Cochrane River. All along the southern border of the Barren Grounds the Blackpoll seems to occupy some of the last outposts of timber.

It is interesting that several species of warblers have a similar northward range, while the various northern flycatchers and the Nighthawk generally fall short of the Barren Grounds, although all these groups are either primarily or exclusively insectivorous. However, the difference in their feeding habits may readily account for the difference in their distribution. The warblers feed mostly on insects living on and sheltered by the vegetation, where they may be found in weather too severe for the flying insects on which the flycatchers and the Nighthawk feed. Thus these last might readily succumb under conditions offering no particular hardship to the warblers.

Seiurus noveboracensis noveboracensis (Gmelin), Northern Water-thrush. —This is apparently one of the rarer summer residents in the Windy River area. One was seen among spruces near the river's mouth on July 23. A week later a male was heard singing at some length in a spruce muskeg farther up the river. It responded readily to the "squeak," and became a specimen. It was somewhat fat and weighed 18.4 g.; testes 1.75×1.50; bill fuscous, base of mandible paler; iris dark olive-brown; tarsus and toes dark grayish brown. The pileum is Clove Brown; rest of upper parts, Olive-Brown. The exposed culmen measures only 12.5, and the under parts are distinctly yellowish (Massicot Yellow). In all these characters the specimen appears closer to *S. n. noveboracensis* than to the weakly differentiated or untenable *S. n. notabilis* Ridgway. Taverner (in Taverner and Sutton, 1934: 71) maintains that the alleged characters of *notabilis* represent individual rather than geographical variation.* Preble (1902: 127) and Fleming (1920: 113) consider specimens from northern Manitoba as more or less intermediate between the two subspecies. (See also McCabe and Miller, 1933.)

Preble (1902: 127) records the species from the Churchill River 15 miles above its mouth; Taverner and Sutton (1934: 70), from Churchill. To the westward, there are records from Athabaska and Great Slave Lakes and a little south of Great Bear Lake (Preble, 1908: 476), and from the Mackenzie Delta (Anderson, 1913: 490); to the southward, from Reindeer and Cochrane Rivers and Reindeer and Du Brochet Lakes (Buchanan, 1920: 261). The breeding range evidently extends only to the border of the Barren Grounds.

Euphagus carolinus carolinus (Müller), Rusty Blackbird.—The Rusty Blackbird spends the summer in small numbers in the Windy River area, where it was observed fairly frequently from June 5 to September 30. On many days only a single bird was seen; the maximum number per day was

* It is obviously through a *lapsus calami* that the author just cited speaks of "white *noveboracensis* and yellow *notabilis*."

about five. During the season I secured records of about 70 individuals, but these doubtless included many "repeats." As far as my observations went, the principal foraging ground was the river shore; next, the sedge bogs and the camp dooryard; less frequented habitats were muskegs, the border of a tundra pond (fig. 4), an upland spruce thicket, and riverside thickets of willow or dwarf birch. The birds resorted to the sedge bogs more particularly in early June, these being the first places to thaw out. Scraps from the camp formed an attraction on the river shore.

The fine song of the species was heard surprisingly few times during the breeding season: perhaps on June 11 (from the top of a spruce in a muskeg), and definitely on June 22 (at the spruce-grown border of a muskeg pond). One bird was seen in pursuit of another (probably a part of courtship behavior) on June 11. On September 10 a bird in rusty winter plumage was giving voice to a whisper song on an island in Windy Bay; and on September 22 a bird was doing likewise while perched on the ground or a low stone in a dwarf birch thicket on a river bluff. The call-note was heard at intervals throughout the season. On July 10 a female in the dooryard came familiarly within 25 feet or so, yet protested my presence with a fairly sharp note—*keck, keck, keck*. Aside from occasional pairs or twos, there was little evidence of flocking—three birds on July 5 and 30 and September 12, and four on August 5.

Between Nueltin Lake and Hudson Bay, the Rusty Blackbird has been found at York Factory, Churchill, and 15 miles up the Churchill River (Preble, 1902: 116); again at Churchill (Taverner and Sutton, 1934: 72); also at Sandhill and Malaher Lakes (Manning, 1948: 20). To the westward and northwestward, it has been recorded at Great Slave and Great Bear Lakes and Athabaska, Slave, Anderson, and Dease Rivers (Preble, 1908: 410), Pike's Portage (Preble, 1911: 388), and Fort Enterprise (Clarke, 1940: 59); to the southward, at Lac du Brochet and Cochrane River (Buchanan, 1920: 250). Thus the species reaches the tree limit at various places, and also goes a little beyond it (*e. g.*, on the Mackenzie Delta—Anderson, 1913; 483 and Porsild, 1943: 33).

Acanthis hornemanni exilipes (Coues), Hoary Redpoll.—This species is apparently somewhat less common than *A. l. linaria* in the Windy River area; it was found also at Josie's Bay. In the field it is frequently difficult or impossible to distinguish between the two Redpoll species, and observations can not always be allocated definitely to the one or the other. None of the birds I saw or collected appeared so light as Fuertes' figure of *exilipes* in Forbush (1929, 3: pl. 65) (*cf.* Taverner, 1926: 279). My records for the season include approximately 19 Hoary Redpolls and 63 Common Redpolls, but among these are many uncertain identifications as well as "repeats."

Late on June 12 a rather light-colored (Hoary?) Redpoll was noted among spruces by the shore of Windy Bay, where it may have been settled for the night. On June 30 two males and a female (presumably Hoary) in company were found among spruces at Windy River. At Josie's Bay, on July 13, a flock of about four was encountered and an adult female was collected in a spruce and tamarack muskeg. One of the birds indulged in a peculiar undulatory flight as if for the purpose of singing on the wing, but I

did not clearly distinguish the sound. In the same locality on July 16 a female perched on the top of a small spruce, uttering a soft, nasal, anxious *tway, tway,* and tilting its tail with each note. Then a male appeared and was collected. On both of these last occasions the birds seemed to show considerable inquisitiveness, traveling for some distance (apparently beyond their own territory) to join other birds that were calling anxiously.

On August 7 a very young specimen, with a half-grown tail, was brought in by Anoteelik from a locality about 2 miles northwest of the Windy River post. On September 3 a Redpoll (sp.?) in the tower of camp headquarters called *tyay, tyay, tyay.* On October 14 two birds, giving the *tway, tway* note, were seen about 6 miles above the mouth of Windy River. At Simons' Lake little flocks of three and two rather light-colored birds were noted on October 16 and 17; they were feeding on dwarf birches in the Barrens.

The adult male and female have wing measurements of 74 and 73; maxilla dusky; mandible slightly paler or yellowish horn color; iris dark olive (female); tarsus and toes fuscous or dark grayish brown; weight, 13.4 (male) and 12.8 g. (female); testes 8.5×5.5; female with a bare brood patch; largest egg in ovary 2 mm.

The juvenile bird of August 7 was so recently out of the nest as to indicate a late breeding season. Its upper parts are Fuscous-Black, the crown feathers edged with Pale Olive-Buff and those of the back with Buffy Brown; general appearance more streaked than in adults; the two Pinkish Buff wing bars broader than in the adults; rump Light Buff, streaked with dusky; chin Dark Mouse Gray; rest of under parts white, well streaked with dusky except on belly and under tail-coverts; a Pale Ochraceous-Buff suffusion on breast, sides, and flanks; bill dusky, tip horn color; iris deep olive-brown; tarsus and toes skin color; weight, 8.05 g.

Charles Schweder (*in litt.*) reported an "Arctic Redpoll" on Windy River on March 15, 1948.

The breeding range of the Hoary Redpoll extends over the Barren Grounds approximately to their southern borders: York Factory and Churchill (Preble, 1902: 118); Churchill (Taverner and Sutton, 1934: 73); Southampton Island (Sutton, 1932: 228); Boulder Lake, Malaher Lake(?), and Tha-anne River (Manning, 1948: 20); Baker Lake, Pond and Milne Inlets, Vansittart Island, and Chesterfield (no exact determination of specimens from these localities) (Hørring, 1937: 113); Plover and Heuss Lakes and Thelon and Hanbury Rivers (Clarke, 1940: 59); Anderson River and Arctic coast to eastward (Preble, 1908: 418); and Coronation Gulf (Anderson, 1913: 484).

The occurrence of both *exilipes* and *linaria* at Churchill and at Nueltin Lake, as well as at Chimo, Ungava (Turner, 1885: 239), during the breeding season refutes Salomonsen's contention (1928: 125) that all forms of Redpolls should be regarded as conspecific (*cf.* Hellmayer, 1938, 11: 268).

Acanthis linaria linaria (Linnaeus), Common Redpoll.—Several Common Redpolls were seen at Churchill on May 21.

In the Windy River area this species appeared to be fairly common through the summer, although specific identification of Redpolls in the field was frequently impossible. Whatever basis there was for identification is

generally mentioned in the following account.

On June 4 a flock of about 10 (sp.?) appeared in a dwarf birch thicket. On June 7 two or three birds were seen in a sedge bog, and an adult male was taken in a mouse trap among dwarf birches near its borders. On June 13 a pair was building a nest in a clump of twigs within a foot of the top of a 10-foot black spruce in a muskeg. On June 22 a bird was gathering Ptarmigan feathers on a ridge in the Barrens about 100 yards away. On July 6 young ones were visible in the nest, and in the evening an adult was sitting on it. Two days later I examined the nest more closely and found three young ones with blackish down. The nest was composed of spruce twigs, grass, and black hairy lichens (probably *Alectoria chalybeiformis* Röhl., which grows commonly on dead twigs of black spruce), and it was lined with a few white Ptarmigan feathers. Absence from the Windy River area from July 10 to 18 prevented me from making further observations.

On June 18, while I was on low Barrens near Duck Bay, three Redpolls flew near me in some excitement. Singing came apparently from a rosy-breasted male. The other two, without rosy breasts, paused in spruces within a rod of me and called *kooee, kooee*. They did not appear to have the light rump of *exilipes*. On June 20 a passing bird called *chik-chik-chik-chik*, etc. On June 23 two birds appeared in the dooryard. On the 26th a male Common Redpoll was feeding among the terminal twigs of dwarf birch in a riverside thicket.

At Josie's Bay, on July 11, two birds were seen in an alder thicket, and presently a group of three. It was difficult to account for the number of adults in the latter group during the nesting season. These were dark-looking birds, apparently Common Redpolls. On the 18th a bird was seen in this locality among spruces, with a rump apparently not white.

On July 22, at Windy River, a juvenile *linaria* among three or four was collected on a gravelly ridge clothed with dwarf birch and black spruce; two other juveniles came to the river's edge to drink, and two birds hopped about the dooryard, one of them approaching confidingly to within 4 feet of me. On July 29 a juvenile *linaria* was collected in a black spruce and dwarf birch thicket near the river. On the 30th a Redpoll (sp.?) called *kay!*, and a juvenile *linaria* was collected in a riverside willow thicket. On August 6 one of two juveniles among dwarf birches was collected. Other Redpolls, either singly or in groups numbering up to four or five, not determined as to species but presumably *linaria* for the most part, were noted in the camp dooryard or adjacent thickets of dwarf birch, spruce, etc., on August 1, 2, 4, 7, 8, 13, and 20. On September 2 there were two birds (identified as *linaria*) among dwarf birches on a ridge in the Barrens; one, in the presence of the other, fluttered its wings—thus rather obviously a young bird begging for food. The date would suggest the possibility of this individual being a member of a second brood. Forbush remarks (1929, 3: 22) that there is "One brood yearly, possibly sometimes two." On September 22 an adult female was collected from a flock of half a dozen Common Redpolls busily feeding among their favorite dwarf birches on the side of a ridge; several clung to the twigs upside down while picking at the seeds.

The Common Redpoll shows a distinct predilection for dwarf birch thickets

as a feeding habitat; very likely this shrub is its most important food plant in its summer home. For nesting and other purposes, it commonly frequents the spruces in the muskegs. It is also found in willow and alder thickets, and makes itself familiar about the camp dooryard.

Ordinarily Charles Schweder does not see Redpolls in winter, but he reported some (perhaps *linaria*) at Putahow River in March, 1947. Taverner and Sutton (1934: 74) refer to this species as only a summer resident at Churchill.

Among six specimens collected, there are an adult male (June 7) and an adult female (September 22). The wing of the male is 75; testes 5.5×5. The weights are 13.6 (male) and 11.95 g. (female). Bare parts of both adults: bill dusky, pale yellow on sides (male), or maxilla dusky and mandible brownish yellow (female); tarsus and toes nearly fuscous (male) or dark olive (female).

Two juvenile males (July 29 and August 6) and two juvenile females (July 22 and 30) are very similar to the juvenile *exilipes*, but their tails are fully developed, their under tail-coverts are streaked, and their rumps are streaked with dusky, whitish, and buffy; skull not granulated; weight, 12.95 and 11.65 g. (males), 12 and 12.8 g. (females); bill dusky; base of mandible paler (males) or horn color (females); iris very dark brown; tarsus and toes grayish brown (males) or skin color (females).

The Common Redpoll evidently breeds through the Hudsonian Zone and along the upper border of the Canadian Zone as well as on the Barren Grounds. East of Nueltin Lake it has been recorded at Churchill (Preble, 1902: 118; Taverner and Sutton, 1934: 74), and at Malaher and Boundary Lakes and Tha-anne River (Manning, 1948: 20); to the northward and westward, on Southampton Island (one record—Sutton, 1932: 232), in the Perry River district (Gavin, 1947: 203), at Coronation Gulf (Anderson, 1913: 484), at Sifton Lake and the Dubawnt River delta (Critchell-Bullock, 1931: 17), at Artillery and Aylmer Lakes (Preble, 1911: 390), at Ptarmigan, Heuss, and Baker Lakes and the Hanbury, Thelon, and upper Coppermine Rivers (Clarke, 1940: 59), and at Fort Simpson, Fort Providence, Great Slave and Great Bear Lakes, and Anderson River (Preble, 1908: 418). To the southward it has been found at Cochrane River and Du Brochet and Kasmere (Theitaga) Lakes (Buchanan, 1920: 251), and at Big Sand and Sandhill Lakes (Manning, 1948: 20).

The A. O. U. Committee on Classification and Nomenclature proposes (*Auk* 61 (3): 461, 1944) to substitute *Acanthis flammea* (Linnaeus, 1758: 182) for *A. linaria* (Linnaeus, 1758: 182), on the basis of line priority. This action accords with that of Hartert (1903, Heft 1: 77), Lönnberg (1931: 306), and Hellmayr (1938, 11: 265). With the exception of Hartert, whose work antedates the International Rules of Zoological Nomenclature, these authors overlook or ignore the provision of Article 28 of the Rules, which states that in the case of two or more synonyms of the same date, the name selected by the first reviser shall stand. The comprehensive list of references given under *Acanthis linaria linaria* by Ridgway (1901: 87-89), and including both Old World and New World literature, gives not the slightest indication that *flammea* was ever selected by a first reviser. In

fact, the only use of this name cited by either Ridgway or Sharpe (Cat. Birds Brit. Mus. 12: 245, 1888) is that by Linné in 1766. Thus, after nearly two centuries of usage, the specific name *linaria* remains valid for the Common Redpoll.

Passerculus sandwichensis oblitus Peters and Griscom, Churchill Savannah Sparrow.—This Savannah Sparrow is a rather common resident in suitable spots in the Windy River area, where it was observed from June 5 to September 26. For the most part it was recorded at intervals of no more than a few days. During the first three weeks of July, however, there was only one observation—along the border between a muskeg and an open bog in the vicinity of Josie's Bay. Its principal natural habitats seem to be the numerous sedge bogs and the riverside meadows. It perches also in the bordering thickets of willow and dwarf birch, and is occasionally found on the ridges in the Barrens. Most commonly of all, however, it was seen in the camp dooryard—only occasionally during the nesting season, but regularly thereafter. Though mainly hopping over the ground, it would sometimes perch on the rooftops or on a wire. A number were collected inadvertently in mouse traps set about the bogs or in a river meadow. In August the birds seemed to make a specialty of pursuing blowflies on caribou meat strewn about the yard. Generally only one or two indviiduals were recorded per day; now and then three or four, and once (August 11) eight or nine. There was scarcely any evidence of flocking. The records for the season indicate approximately 127 individual occurrences, but they undoubtedly include a very large proportion of "repeats."

This is a demure, unassertive little bird, not inclined to do anything to draw attention to itself, aside from its necessary indulgence in weak song. There is a minimum of exhibitionism in its make-up. Not only is its song a very minor one, but it seems to have an exceptionally brief season. I heard it on only three days, from June 22 to 26. It impressed me as perhaps briefer and more subdued than the song of *P. s. savanna*, which I used to hear on the upland fields of central New York. Instead of the latter bird's *tsip-tsip-tseeer'-tseer* (as I remember it), this one seemed to sing *sizzyleézy*. One singing area was a growth of *Calamagrostis canadensis*, willow, and dwarf birch on the borders of Windy River; another, an extensive sedge bog half a mile from the river. The call-note is a slight *tsit*, probably slighter than the Tree Sparrow's likewise represented note. Even this was heard on only half a dozen occasions, from June 22 to August 2, and generally in a nesting area.

On August 14 and 15 a Savannah Sparrow made itself very free with several of the tethered Husky dogs at camp. It would circumnavigate one of the animals, approaching it within a couple of inches. It was engaged in pecking at insects (doubtless mosquitoes and black flies). In so doing, it once leaped against a reclining dog's back; then it landed on the animal's ear, momentarily awakening it. It also hopped on the tail and hind foot of another dog. Although the dogs might stir at these little disturbances, causing the bird to flit away for a few moments, they made no effort to snap at it even when it came almost to the tip of a nose. Cabot (1912: 56) has recorded even greater familiarity with a dog in Labrador on the part of a White-crowned Sparrow.

The few birds that came to the dooryard almost daily in early September seemed to disappear after the 11th; but one or two more (perhaps migrants from farther north) appeared thereabouts from the 22nd to the 26th.

The material collected includes three breeding males (June 5 to 8), one adult female (August 22), and one male and three females in juvenal plumage (August 7 to 15).

The original account of this subspecies (Peters and Griscom, 1938: 454) consists of a comparative diagnosis rather than a detailed description of the adults, with no discussion of immature plumages. Thus the following notes may be useful in supplementing the original account.

In the breeding males the feathers of the upper parts have black centers and are edged with Pale Drab-Gray to Cinnamon-Drab or Light Brownish Olive; nape paler (the black centers of the feathers restricted); median crown streak Pale Olive-Buff; broad superciliary stripe Strontian Yellow; lower part of eye-ring slightly duller; ear coverts Olive-Buff; primaries Hair Brown, with narrow, pale outer edges; coverts edged with Pale Drab-Gray to Light Cinnamon-Drab; rectrices fuscous, with narrow, pale outer edges; under parts white (washed to some extent with Light Buff), well streaked with black on sides of throat, on breast, sides, and flanks; middle of throat slightly or scarcely spotted; maxilla fuscous; tomia and mandible horn color; iris olive-brown; tarsus and toes very pale brownish. Wing, 71-73 (72); culmen, 9-10 (9.5); depth of bill, 5; testes, 9×5.5 to 10×6; weight, 20.2-20.8 g. (20.5).

An adult female of August 22 is in postnuptial molt, with tail feathers about half grown; superciliary stripe Light Buff; weight, 19.55 g.

In the juvenal plumage the coloration above is distinctly buffier, especially on the nape, where it varies to Dark Olive-Buff; wing and tail feathers Fuscous-Black to Black; primaries and rectrices with narrow, pale outer edges; outer margin of secondaries Cinnamon-Brown; throat Light Buff; breast Warm Buff; under parts in general streaked as in adults, but streaks perhaps broader; belly washed more or less with Light Buff; superciliary stripe Light Buff, streaked with blackish; maxilla dusky brown; tomia and mandible horn color; iris dark olive; tarsus and toes skin color. The skulls were not granulated. Weight of one male, 17.8; of three females, 16.3-18.8 g.

Savannah Sparrows (without regard to subspecific determination) have been recorded from the following localities in neighboring regions. To the eastward: Churchill (Preble, 1902: 120; Taverner and Sutton, 1934: 75); 50 miles south of Eskimo Point (Preble, 1902: 120); Southampton Island (one record) and Chesterfield (Sutton, 1932: 235); Neck, Sandhill, Boundary, Malaher, South Henik, Camp, Carr, Alder, Victory, and Derby Lakes and Tha-anne River (Manning, 1948: 21). To the northward: Coronation Gulf (Anderson, 1913: 485), and along the entire route between Artillery and Baker Lakes (Clarke, 1940: 60). To the westward: Athabaska, Great Slave, and Great Bear Lakes and Anderson River (Preble, 1908: 427); Artillery, Clinton-Colden, and Aylmer Lakes (Preble, 1911: 392); and Campbell Lake (Critchell-Bullock, 1931: 18). To the southward: Reindeer and Du Brochet Lakes and Cochrane River (Buchanan, 1920: 252).

Junco hyemalis hyemalis (Linnaeus), Slate-colored Junco.—At Churchill, on May 26, a Junco was seen inside the grain elevator! At the Windy River

post a single bird was seen in the dooryard on June 7, 9, 10, and 26; none thereafter. No song or call-note was heard.

Apparently the numbers of this species diminish rather decidedly toward the tree limit in most parts of northwestern Canada, although Porsild (1943: 34) reports it "breeding abundantly well beyond the tree limit" on the Mackenzie Delta. Between Nueltin Lake and Hudson Bay, it has been recorded at Churchill (Preble, 1902: 122; Taverner and Sutton, 1934: 75) and at Sandhill Lake (Manning, 1948: 22); to the northeastward, at Southampton Island (Sutton, 1932: 235) and Repulse Bay (Bray, 1943: 534); to the westward and northwestward, at Athabaska, Great Slave, and Great Bear Lakes, Anderson River, and Baillie Island on the Arctic coast (Preble, 1908: 440), and on Dease River (Anderson, 1913: 487); and to the southward, at Reindeer and Du Brochet Lakes and Cochrane River (Buchanan, 1920: 225).

Spizella arborea arborea (Wilson), Eastern Tree Sparrow.—Among the sparrows of the Windy River area, this species apparently ranks next to Harris's Sparrow in abundance. It was present in 1947 from June 5 to October 5, appearing a day later than Harris's Sparrow. Throughout the season it was recorded nearly every day except in the periods between the following dates: July 3-11, July 30-August 8, August 26-September 1, September 4-16, and September 30-October 5. The September 4-16 interval may have represented a gap between small migratory waves; the one between September 30 and October 5, simply the melting away of the local population in the last stages of migration. No significance is seen in the other intervals, when the birds probably did not come under observation through mere accident. Only occasionally were more than two, three, or four birds recorded per day. The largest daily numbers—a dozen or so on June 5 and on June 11—probably represented a concentration during migration. Otherwise no more than approximately six to eight were recorded per day, and this many on no more than half a dozen days. My records for the season cover about 152 individual occurrences, including "repeats." As far as I observed, flocking scarcely occurs in this region; it would appear that the flocks break up before the spring arrival, and form again after the autumn departure.

At Josie's Bay, July 11 to 18, the species was found in practically the same numbers as along the Windy River.

The Tree Sparrow is far from particular in its choice of local habitats. It seems to frequent practically all the terrestrial habitats except perhaps the denser and more extensive tracts of spruce. The thickets of dwarf birch, interspersed with a few small black spruces, that commonly occupy the river bluffs and the slopes of ridges in the Barrens (fig. 2), are distinctly favored areas. From these places of shelter the birds venture out into the open Barrens and into the bogs (perhaps especially those that include a few clumps of shrubs or small spruces). They came into the dooryard rather infrequently—for the most part after the young ones in juvenal plumage were stirring abroad. One of the latter even perched on a cabin roof. A few birds were found in willow thickets. A number were captured inadvertently in mouse traps set on a river bluff and in the Barrens.

Singing, first recorded on June 8, continued to be heard fairly regularly till July 25, but only sporadically thereafter (August 8, 21, and 23). At

times the song seemed to consist merely of a simple *chee-chee-chee-chee;* but once it was a little more elaborate. The tip of a small spruce was noted as a singing perch on a couple of occasions. The call-note was heard on June 14, several times during the nesting period (July 16 to 28), and finally on September 19. Thus it was uttered mainly by a parent concerned for the safety of nest or young ones. One such bird, in a muskeg at Josie's Bay on July 16, kept up a constant, sharp *tsit, tsit, tsit,* etc., punctuating each note with a tilt of the tail. It flew here and there among the spruces and tamaracks, sometimes perching on the tip, sometimes in the branches. Finally it came within 7 feet of me. The next day, in the same general locality, a bird came within 10 feet as it gave its anxious note; it had a lepidopterous insect in its bill, which it presently swallowed instead of delivering to some concealed young one. The "cheerful twitter" of the winter flocks, "each bird repeating the syllables *teel-wit* in a sweet, lively tone" (Hoffmann, 1910: 163), was not heard at all here in the summer home; it would appear to be reserved for the flocking period.

In contrast to the number of nests of Harris's Sparrow that were located, I found not one of the Tree Sparrow, which would seem to be somewhat more adept at concealing its nest. A fledgling, brought in from the river bluff by one of the children of the camp on July 22, was the first one noted. On the 29th another juvenile bird was collected in a riverside willow thicket. On August 10 and 19 one of these youngsters appeared in the dooryard; on the 12th one was collected in the Barrens on the summit of the Windy Hills; on the 17th one was caught in a mouse trap on a ridge in the Barrens; on the 18th one was likewise caught in a caribou trail along a river bluff; on August 26 and September 3 young birds still had streaked breasts.

The individuals noted thereafter appeared to be in either first winter or adult plumage. An adult female taken on September 23 had a crowberry (*Empetrum*) in its bill; the age of this specimen was interesting in indicating that it was not merely immature birds that lingered toward the end of the season. After September 27 only two or three Tree Sparrows came under observation; these were reported by Charles Schweder on September 30 and October 5, at some distance from camp.

The specimens collected include two adult males, two adult females, and three males in streaked juvenal plumage—all distinctly referable to the typical subspecies. The adult males (June 11 and 17) had testes 12×7 and 11×7.5; body weights, 18.45 and 18.1 g. The largest egg in the ovary of an adult female of June 27 was 5 mm. in diameter; body weight of this female, 18.6 g.; of the other adult female (September 23), 17.6 g. The weights of three juvenile males (July 23 and 29, August 12) were 13.8, 18.7, and 19.5 g., the last two exceeding the adults in weight; their skulls were not granulated.

Bare parts of adults: maxilla dusky; mandible dusky at tip, corn yellow at base; iris olive-brown; tarsus pale brownish, toes a little darker. Bare parts of juvenile males: bill dusky, base of mandible horn color; iris dark olive-brown; tarsus and toes pale brownish.

To the eastward, the Tree Sparrow has been recorded at Churchill (Preble, 1902: 122; Taverner and Sutton, 1934: 76); 50 miles south of Eskimo Point

(Preble, 1902: 122); at Sandhill, Boundary, Malaher, Boulder, South Henik, Camp, and Carr Lakes and Tha-anne River (Manning, 1948: 22). To the northward and northwestward: at Franklin Bay and Coronation Gulf (Anderson, 1913: 486); Sifton Lake (Critchell-Bullock, 1931: 18); Artillery, Hoare, Beverly, and Baker Lakes and Hanbury and Thelon Rivers (Clarke, 1940: 60). To the westward: at Great Slave and Great Bear Lakes and Anderson River (*S. a. ochracea* at the last locality) (Preble, 1908: 435, 436); Pike's Portage to Back's River (Preble, 1911: 394); and Hill Island Lake (Harper, 1915: 161). To the southward: at Reindeer Lake and Cochrane River (Buchanan, 1920: 250). The breeding range seems to extend southward throughout the Hudsonian Zone.

Zonotrichia querula (Nuttall), Harris's Sparrow.—*Local status:* This big, heavy sparrow, distinguished by the success with which it eluded the oologists for so many years, nests in considerable numbers in the Windy River area, where it was present from June 4 to September 17. Here it is apparently the commonest of all passerine summer residents. It came nearer than any other bird to being recorded every day during the season. The maximum interval without a record was four days between July 31 and August 5; there were only two other intervals of as many as two days. In mid-July it was fully as common at Josie's Bay as along the Windy River. Here I found two nests and a fledgling of another brood in an area perhaps no more than half a dozen acres in extent. Despite the fairly ubiquitous occurrence of the species, it was only infrequently that I recorded more than four or five individuals during the course of a day. My records of about 255 individual occurrences during the season naturally include many multiple countings. I found virtually no evidence of flocking, even when the birds were arriving

Fig. 6.—Site of Harris's Sparrow's nest, on ground in a clump of dwarf birch at left of pack-sack, on a ridge in the Barren Grounds at the mouth of Windy River. Black spruce in the distance. July 27, 1947.

from, or departing for, their winter haunts.

Habitats. These sparrows were noticed most commonly in the little patches of spruce that form outposts of timber along the borders of the Barrens and generally have an adjacent growth of knee-high dwarf birch (fig. 6.) It may be that many of the birds seen on the spruces had just previously been feeding among the birches or out in the edge of the Barrens, and had sought an elevated perch from which to watch the intruder or to protest his presence. Now and then they were found in rather extensive tracts of spruce on the uplands. The birds not only move about on the open Barrens, but may occasionally nest there. They resort in numbers to the dwarf birch thickets on the river bluffs (many of them containing a few spruces) and on the river shores (fig. 2). They are also found to some extent in the more or less open muskegs, with a scattered growth of black spruce and tamarack.

The camp dooryard attracted many Harris's Sparrows, and more of them were actually observed there than in any other habitat except the first one mentioned above. Several appeared there during snowy, cold, or blustery weather on June 6, 7, and 8, while migration may have been still in progress. During the nesting season the adults came only infrequently or irregularly; but from August 6 to September 12 the young birds of the year were practically daily visitors, and some even perched on the roofs of the cabins. Dur-

Fig. 7.—Harris's Sparrow's nest with five eggs (one embedded in the side), on Camp Ridge near the mouth of Windy River. Constructed of grasses, moss, and reindeer lichen, with mountain cranberry growing beside it, in a clump of dwarf birch. July 1, 1947.

Fig. 8.—Three young Harris's Sparrows, with dense protective down, in the nest whose site is shown in figure 6. July 27, 1947

ing these last two months the old birds seemed to avoid the camp area.

Voice: The first song was noted on June 8, four days after the spring arrival, but it was not until the 14th that singing became general. Thereafter it was heard nearly every day through June 23, when a lull of five days seemed to ensue. From June 29 to July 20 singing was recorded rather commonly; the latter date apparently marked the end of the season. On July 16, when a decline in general bird song had become evident, this species was still singing freely. A characteristic singing perch is the tip of some small black spruce. Here the bird elevates its head but scarcely upturns its bill while giving voice to a long-drawn-out whistle, somewhat like the Whitethroat's in tone, but without the endearing, tremulous quality of the latter, and rather colorless or spiritless by comparison. It has a plaintive, almost doleful sound, more like a dirge than a nuptial carol. The bird may sing a phrase of two notes, *pheeeee-pheeeee;* then, perhaps changing the key slightly, add three more, *pheeeee-pheeeee-pheeeee.* Although Nuttall doubtless bestowed the name "Mourning Sparrow" in reference to the conspicuous amount of black in its plumage, the appellation would be almost as appropriate by reason of its song.

The adults seem to reserve their call-note mainly for expressing concern over intrusion into their nesting territories. Thus it was not recorded till June 17, nearly two weeks after the species had arrived in the vicinity. It may

be described as a sharp or slightly metallic, petulant, cheeping *tsweet*. From late June through July it is heard all about the borders of the Barrens; it may then be considered perhaps the most characteristic of the local bird voices, as the cackling of the Willow Ptarmigan is in early June. When one bird (perhaps the male) begins cheeping, it is soon joined by its mate. At such times they seem to have a penchant for perching on the wide branches of any available tamarack rather than on the tip of a spindly black spruce, although the latter sometimes serves. A fledgling, when taken in hand on July 17, gave a pretty fair approximation to the adult's *tsweet;* once or twice it also uttered a distress cry, *tsreep!*, to which an old bird responded by coming nearer. The few call-notes heard from August 14 to September 10 seemed to come mainly, if not solely, from immature birds.

Fig. 9.—Harris's Sparrow in first winter plumage, eating cornmeal at Windy River post. August 22, 1947.

Nuptial behavior: At the nesting season there were a few evidences of antagonism between rival birds (presumably males). On June 23 two were "engaged in altercation, or feints at fighting, much like a couple of Robins at home." At Josie's Bay, on July 12, "two on a boulder adopted a threatening attitude toward each other, with lowered heads, like cockerels."

Nesting: Several nests were found near Windy River through a chance flushing of the sitting bird, and doubtless others could have been brought to light by a little direct effort. The generally selected location is on the ground just within a rather low clump of dwarf birch, perhaps a foot high, in the edge of the Barrens and not more than a few rods from the nearest cluster of spruces. On June 30 a nest in such a location on the Middle Ridge contained two eggs. There were no more on July 3, though a sitting bird was flushed and proceeded to cheep in characteristic manner from the tip of a neighboring spruce. When next visited on July 26, the deserted nest contained only one egg; and the same condition remained on August 5 and an September 3. On July 1 a similarly situated nest, on the summit of Camp Ridge, contained five eggs—four in a normal position and one embedded in the side of the cup. It was constructed of grass, moss, and *Cladonia* (fig. 7).

On July 26 the little Eskimo girl pointed out a nest on the promontory at the mouth of the river (fig. 6). It contained three young ones clothed with down. It was amazing how this thin, fluffy, wide-spreading down stood erect for nearly an inch, forming such a protective canopy over the callow nestlings (fig. 8) that only two or three black flies managed to crawl over their bodies while I watched, although my own clothes were simply covered

with these scourges of the Barren Grounds. (One of the nestlings appeared to squirm as a black fly reached a bare spot between the down.) It was an impressive illustration of the manner in which nature has provided an essential protection for a bird at a normally weak point in its life history. No one could guess, from observing the matted down in a made-up specimen, how thoroughly the live bird was safeguarded. It would be interesting to investigate the nestlings of Arctic or Subarctic passerines in general, to ascertain to what etxent they may be similarly protected. The fact that Harris's Sparrow has survived as such a common species while breeding in this region is sufficient evidence that there is no devastating mortality from dipterous attacks on nestlings. I collected one of these downies on July 27, and the others may have been able to develop to the point of leaving the nest before August 6 when I found it empty.

At Josie's Bay three nests were discovered in July. On the 14th I was sitting quietly, while transferring an insect from a net to a bottle, when a Harris's Sparrow, after cheeping a bit, disappeared into a bed of dwarf birch about 20 feet from the shore. I walked directly to the spot and found four slightly feathered young in the nest. Two days later these nestlings, then half feathered, were dead from no evident cause, and no solicitous adults were about. On the 15th a nest with two eggs was found on upland Barrens 40-50 yards beyond some spruce woods. It was flush with the ground, about 6 inches from a large rock. The lining was of fine grasses; the exterior was composed in part of *Cladonia*. The cup was 60 mm. in both width and depth. This was the only nest I found that was not located among dwarf birches. In close proximity were dwarf willow and alpine bearberry, not recorded about the other nests. On the 16th I flushed a bird from a nest of two eggs about 30 feet from a cove of the bay. One edge was flush with the sloping ground. It was made of small twigs, with a lining of grass. On the 18th this nest contained three eggs, but no more on the 20th, when the nest and its contents were collected.

The plants recorded in close proximity to the six nests were the following (listed in approximate order of frequency): *Betula glandulosa, Vaccinium uliginosum, Cladonia, Vaccinium vitis-idaea, Empetrum, Ledum decumbens, Andromeda, Sphagnum, Loiseleuria, Salix* sp., *Arctostaphylos alpina,* and moss (perhaps *Polytrichum piliferum*). Some of these grew within, some without, the surrounding beds of dwarf birch. The absence of spruce from this list is perhaps worthy of note.

The first evidence of hatching was noted on July 11, when an adult at Josie's Bay was carrying food in its bill. Here, on July 17, two adults had been cheeping for perhaps three-quarters of an hour, perching in spruces and alders and on the ground and boulders, and approaching within 25 feet of me, before a fledgling was glimpsed hopping over the Barrens. Young in the nest were found on July 14 and 26, as recorded above. The latter case may have represented a second brood, perhaps after loss of a first set of eggs or young. Fledglings were taken along the Windy River on July 20 and 23. By July 25 the sharp call-note was heard on all sides, as the fledglings were spreading abroad and bringing fresh anxiety to their parents. Nearly every little patch of spruce scattered over the hills and ridges of the Barrens seemed

to harbor a cheeping adult or two that would protest my approach. The fledglings, however, were extraordinarily adept at keeping under cover or, at any rate, escaping detection.

Molt: On August 6 the first bird in juvenal plumage leading an independent existence was noted at camp; by that date it was beginning to molt into the first winter plumage, at an age of probably less than a month. On August 12 four or five immature birds appeared in the trees of a muskeg; they were no longer skulking under cover of the shrubbery.

Fall migration: By August 9 adults seemed far less in evidence than immature birds. From this time on I recorded adults only as follows: one on August 15; one reported by Fred Schweder, Jr., on August 19; two seen on August 21 (one of them bob-tailed and presumably molting). Thereafter nearly every bird was recorded as immature; a few others, without indication of age. It seemed fairly obvious that at least the great majority of the adults of this species, like those of some shore birds, undertake their fall migration considerably in advance of the birds of the year. In late August, and up to September 12, from one to several birds were seen practically every day, chiefly in the dooryard. A period of colder, blustery weather then set in, and the birds became distinctly scarcer, deserting the dooryard entirely. Fred Schweder, Jr., reported one elsewhere on the 15th, while I saw another on the 17th, and single birds, not completely identified, on the 19th and 20th. These final dates may be compared with the latest record (September 5) at Churchill (Taverner and Sutton, 1934: 77).

General behavior: On June 26 a Harris's Sparrow came hopping jauntily over the ground in the dooryard, among the wood chips, meanwhile flirting its tail up and down. It would pause to scratch like a Chewink or a Fox Sparrow, jumping forward several inches, then immediately scraping backward with both feet on the surface for an equal distance. The dooryard evidently made a better scratching place than other spots in the natural environment. The bird's familiarity here at the camp permitted closer observation than off in the bush.

An individual at Josie's Bay on July 14, foraging over the rocky Barrens just above the alder fringe along the shore, hopped along very actively, rather jerkily, and almost bobbing its head. Every now and then it would peck on the ground, perhaps after insects. It would also mount some small boulder in its path, as if for a temporary vantage-point.

A bird in process of acquiring the first winter plumage was feeding over the dooryard on August 10. It would make from one to a dozen hops in a series, but usually three or four; it would pause now and then to give a little tilt to its tail, and anon peck at something on the ground. It came fearlessly within a couple of yards of me. By August 14 some birds of the year were in evidence in the camp area practically all day (fig. 9). On this day one of them allowed me to operate a camera from a distance of 6 feet while it was pecking at cornmeal or bread crumbs in a feeding tray. This bird or one like it pursued an insect through the air and presumably captured it.

Ectoparasites: The following Mallophaga were collected from three adult males (two on June 17, one on June 27): *Ricinus hastatus*, *Brüelia* sp., and *Philopterus subflavescens*.

Specimens: The specimens collected include four adult males, a nest with three eggs, a downy nestling, two males and one female in juvenal plumage, and three birds (one a female) molting into first winter plumage. In these last no granulation of the skull was evident.

Birds of this and two other passerine species (*Anthus rubescens rubescens* and *Spizella arborea arborea*) exhibited a tendency toward being slightly fatter and heavier on their first arrival early in June than one, two, or three weeks later. Possibly they had outstripped the season in the last stage of their northward migration and had thus found a more limited food supply here than in the country to the southward; on the other hand, they may, on their arrival here, have neglected feeding somewhat in the ardor of their nuptial activities. Toward the end of June there appeared to be a general increase in weight, indicating perhaps an improvement in the food supply as well as a reduction in the strain of the breeding season, after territories were established and incubation was under way. The weights of four adult males were: 41.1 (June 11), 37.9 and 36.8 (June 17), and 41.7 g. (June 27). Their testes measured: 14.5×8.5, 14×7.5, 12.5×8.5, 14×9.

In the nestling of July 27 (female; 13 g.) the feather tracts of the sides of the head, under parts, and legs are flat and scalelike, with no down. The tracts of the upper parts are well furnished with Chaetura Drab down; that on the crown is particularly luxuriant. Wing feathers have just begun to sprout from their sheaths. The merest stub of tail feathers has appeared.

Juvenal plumage is represented by two males (July 20, 19.9 g.; July 23, 33.6 g.) and one female (July 17, 22 g.). The stubby tails vary from about 9 to 38 mm. in length. The feathers of the crown and back appear more broadly black than in the first winter plumage; their edges vary from Pale Ochraceous-Buff on the crown (where narrow) to Cinnamon-Buff on the back; postocular stripe Pale to Light Ochraceous-Buff; ear coverts Pinkish Buff, obscurely streaked; wing feathers Fuscous-Black, their outer edges varying from Light Buff on the primaries to Sayal Brown on the secondaries; two wing-bars of Pinkish Buff; tail feathers Fuscous, edged and tipped with Pale Olive-Buff; upper tail-coverts Saccardo's Umber, the feathers with blackish centers. Under parts Pale Olive-Buff, varying to Pinkish Buff on breast and under tail-coverts; rather heavily streaked with blackish except on mid-venter and under tail-coverts; middle of throat obscurely streaked; a prominent blackish malar streak. Previous descriptions of this plumage (Preble, 1902: 121; Fleming, 1920: 112-113) have not been expressed in Ridgwayan terms.

Three birds molting into first winter plumage (August 6, 12, and 15) do not show any granulation of the skull. White feathers have begun to appear on the breast and belly.

Distribution: Harris's Sparrow breeds from the outposts of timber in the Barren Grounds southward through the upper part of the Hudsonian Zone. It has been found in summer at Churchill (Preble, 1902: 120; Taverner and Sutton, 1934: 77); at Sandhill, Malaher, Boundary, Boulder, and South Henik Lakes and Tha-anne River (Manning, 1948: 22); at Great Bear Lake (Preble, 1908: 430); from the eastern part of Great Slave Lake to Artillery Lake (Preble, 1911: 392); at Nonacho and Ptarmigan Lakes and Hanbury and Thelon Rivers (Clarke, 1940: 60); on the Mackenzie Delta (Porsild,

1943: 34); at Cochrane River and Lac du Brochet (Buchanan, 1920: 252); and at Nahili Lake, near the south end of Nueltin Lake (Downes, 1943: 174). So far there seems to be no midsummer record from the more southerly parts of the Hudsonian Zone. Thus the statement by Semple and Sutton (1932: 167), that the breeding range extends "probably throughout the belt of stunted trees which is characteristic of the Hudsonian Life Zone," evidently requires modification.

The breeding range, approximately 300 miles in north-south extent in Keewatin and Manitoba, seems to become progressively narrower toward its northwestern extremity at the Mackenzie Delta. It is significant that such a competent naturalist as Sir John Richardson failed to note this conspicuous species about Great Bear Lake in the 1820's, while Roderick MacFarlane did likewise in the Anderson River region in the 1860's. In fact, Harris's Sparrow seems not to have been recorded anywhere in the Athabaska or Mackenzie Basins by naturalists of the nineteenth century (*cf.* Preble, 1908: 430-431). One can hardly fail to conclude that the advance of the species into this region is a comparatively recent accomplishment.

Its distribution in the United States during its migrations and in winter, as mapped by Swenk and Stevens (1929: 174, fig. 1), shows interesting correlations with certain physiographic divisions of the country (Fenneman, Map of the Physical Divisions of the United States, U. S. Geol. Survey, 1930). The "all-winter range" coincides roughly with the southern part of the Dissected Till Plains and with the Osage Plains (both in the Central Lowland), and with the Texas Hill Section of the Great Plains Province. The species is a more or less common migrant farther northward, in the Western Lake Section, the Wisconsin Driftless Section, and the northern part of the Dissected Till Plains (all in the Central Lowland). It is an irregular and rather uncommon migrant to the eastward of the sections just mentioned, in the Till Plains and the Eastern Lake Section of the Central Lowland and in the Superior Upland; also to the westward, in the Plains Border, the Colorado Piedmont, the High Plains, and the Missouri Plateau (unglaciated), all in the Great Plains Province.

Zonotrichia nigrilora Todd, Eastern White-crowned Sparrow.—Todd's argument (1948: 19-20) in favor of applying Forster's name, *Emberiza leucophrys* (1772: 403, 426), to Gambel's Sparrow rather than to the Eastern White-crowned Sparrow, impresses me as altogether inconclusive. The fact remains that Forster's description does not cover the crucial diagnostic point —the color of the lores; therefore it may be taken to apply to either bird. Acceptance of Todd's proposal would involve a most confusing and unfortunate shift of names. Probably the simplest and most satisfactory solution of the problem is to consider Forster's description indeterminable and to discard his name entirely. This leaves the way open to adopt *nigrilora* Todd as the name of the Eastern White-crowned Sparrow, and to retain *gambelii* Nuttall for Gambel's Sparrow.

In any event, Todd's assumption that Gambel's Sparrow is the more numerous of the two species at Fort Severn is definitely weakened by the fact that Preble (1902 : 121) reports the Eastern White-crowned Sparrow as

abundant at York Factory, with no record at all of Gambel's Sparrow in that area.

The application of the name *leucophrys* is further discussed by Manning (1949: 215). Although the International Rules apparently do not apply any law of priority to cases of restriction of type locality, it is generally customary to regard the first restriction as valid, under a sort of unwritten law of priority. Thus the Severn River (or Fort Severn) may be regarded as the validly restricted type locality of *Emberiza leucophrys* Forster, whether the restriction dates from the A. O. U. *Check-List* of 1931, from Hellmayr (1938: 566), or from Todd's paper of 1948. However happily the nomenclatural question might have been solved by the selection of Albany River as the restricted type locality, Manning's suggestion to that effect is evidently too late.

Manning (1949: 215) actually records a single specimen that "could be referred to *Z. l. gambelii*," though taken among a typical "*leucophrys*" population at Kinglet Lake, Ungava.

The taxonomic relationships of these two birds have puzzled ornithologists for decades. Currently they are treated by most authors as conspecific, despite the fact that both forms occur together over a vast extent of breeding territory, from the shores of Hudson Bay westward for some hundreds of miles. Preble (1908: 431) records a June specimen of the Eastern White-crowned Sparrow (taken by Kennicott) from as far west as Fort Resolution. At Hill Island Lake, Mackenzie (north of Lake Athabaska), on July 14, 1914, I observed, in addition to some juvenile individuals, "at least one adult. I took particular notice of the loral region, and saw that it was black: therefore, not *gambelii*." During the next two days, however, I noted a number of Gambel's Sparrows and collected one of them. Such association at the breeding season over such a wide territory so violates our concepts of normal subspecific relationships that I propose to treat the two birds as specifically distinct, though I readily grant that this is merely a working hypothesis and not a final solution of a vexatious problem (*cf.* Swarth, 1926: 123-124; Grinnell, 1928: 186-189; Swenk, 1930; Oberholser, 1932: 12; van Rossem, 1945: 284-285; Rand, 1948a: 426, 1948b: 91-103, and 1948c: 318-319, fig. 5). (I leave entirely aside the nomenclatural questions involved in the relationships between either of these birds and the several more westerly forms generally considered conspecific with them.) If Gambel's Sparrow and the Eastern White-crowned Sparrow were actually subspecies, or geographical representatives, of a single species, it is scarcely conceivable that they could have shared a breeding territory hundreds of miles in extent for at least scores, probably hundreds, and perhaps thousands of years, without becoming thoroughly amalgamated. The intermediate specimens reported may be accounted for by hybridization between two extremely similar species. The fact that so many thoroughly typical examples of each species still occur in this common territory brings up the question of sterility in hybrid offspring, militating against the endless multiplication of intermediates. In discussing the somewhat analogous case of the Yellow-shafted and the Red-shafted Flickers, Taverner remarks (1934: 35) on the possible existence of some factor "to prevent indefinite continuance of the hybrid strain in competition with either parent stock." It may be added that Miller (1940) has described a hybrid between *Zonotrichia coro-*

nata and *Z. leucophrys* (*gambelii*).

To distinguish between adults of the two species in the field, a reasonably close view is necessary; a fleeting or distant glimpse scarcely suffices. As for juvenile and first-winter birds, the task of discriminating between the two species, even with a specimen in the hand, is at best difficult and unsatisfactory. The color *pattern* in the loral region of immature birds seems to be identical in both species.

The White-crowned Sparrow seemed somewhat the less common of the two in the Windy River area. Even if both species were considered as one population, they were apparently outnumbered by the Tree Sparrow as well as by Harris's Sparrow.

On June 9 an adult male Whitecrown was taken in a mouse trap among dwarf birches and other low vegetation along the base of a ridge in the Barrens. On June 26 an adult female was collected in a patch of spruce and tamarack near Little River. Other adults noted during the season were either Gambel's Sparrows or not observed closely enough to permit a discrimination between the two species. No singing was noted on the part of any bird identified as the present species. The numerous immature birds observed in August and September (including a few that were collected) are discussed in the account of Gambel's Sparrow.

In the male of June 9 the bill was brownish horn color; tip of maxilla fuscous; iris olive-brown; tarsus light brownish, toes slightly darker; testes 10×6.5 (not pigmented); body weight, 28 g. In the female of June 26 the bill was bright flesh color; iris bright olive-brown; tarsus and toes pale brownish; largest egg in ovary 10 mm.; weight, 31.4 g.

White-crowned Sparrows have been recorded along the western side of Hudson Bay from Severn River, Severn House, Hayes River, York Factory, and Churchill (Preble, 1902: 121); from Churchill (Taverner and Sutton, 1934: 77; Grinnell and Palmer, 1941: 53); and from Bird, Ilford, Herchmer, and Churchill (Rand, 1948b: 92, 98). Two records from Mackenzie (Fort Resolution and Hill Island Lake) have already been mentioned.

Zonotrichia gambelii (Nuttall), Gambel's Sparrow.—From June 4 to July 10 single birds were noted on 16 days in the dooryard or elsewhere in the vicinity of camp. On some of these days (June 5, 11, 12, 28; July 5, 9, 10) their lores were recorded as either grayish or white, and so their identity was fixed as Gambel's Sparrows. On the other days insufficient observation did not permit me to decide between this and the preceding species. One of these uncertain birds sang from the top of a spruce on June 10, giving a song a little like my representation of that of Gambel's Sparrow at Fort McMurray on the Athabaska River in May, 1920: *fee-glee, hee-lee-rrhu*. (Another rendering at that time was *feee-glee-hee-hee-hee-glee-clrrr*, the last three notes being burry.) On June 28 a bird with gray lores, perched in a spruce clump on the slope just above camp, tilted up its bill to sing: *fee-fee-fee, hee-hée-glee*. Sometimes its song seemed to terminate in a sort of trilling *chit-it-it-it-it*. This was a one-legged bird, very pathetic as it sang from a squatting position on a spruce limb, to rest its overworked remaining leg. Another bird, able-bodied and with apparently similar lores, was near by. It was not until July 9 and 10 that I recorded the first call-notes (*tsit*) from this species.

At Jose's Bay, on July 11, a bird with grayish lores gave the same call-note. Here a song was heard on July 16, but I did not obtain a view of the singer.

About the mouth of Windy River birds were observed, for the most part singly, on July 22 and almost daily from July 29 to September 11 and from September 16 to 20. From August 2 to September 10 the great majority of these were immature; none of this age were seen after the latter date. Apparently the birds of the year do not migrate before they have completed the postjuvenal molt. Adults were recorded on July 22 and 29, August 3, 8, 14, and 25, and September 6, 10, 11, 16, 17, and 20. Positive identification of adults as Gambel's Sparrows was made only on July 29 and September 16; immature birds could not be specifically determined in the field. I consider it likely, however, that at least the majority were of the present species rather than the Eastern White-crowned Sparrow. My records of both species together indicated about 101 individual occurrences.

One of the last songs heard came from a spruce thicket on July 29; the bird was collected and proved to be a Gambel's Sparrow. Another bird, unseen, sang as late as August 6. In general, the birds seemed remarkably silent during the latter part of the season; even the call-note was recorded but twice after July 11—on August 14 and September 19.

More of the birds were observed in the dooryard than in all other habitats combined. This was particularly true of the immature individuals in August and September; some of them even hopped over the roofs of the cabins. One, at my approach, flew through the open doorway into a cabin. The other principal habitat was the little thickets of black spruce, more or less mixed with or surrounded by dwarf birch bushes, and generally on the upland rather than in a bog or muskeg. The birds seem very little inclined to venture away from such shelter into the edge of the Barrens. Several were inadvertently taken in mouse traps.

In August the immatures were among the commonest of the passerine species frequenting the dooryard, where they fed over the bare area littered with wood chips. They were much more confiding than the adults. The latter only rarely ventured into the dooryard in August, though several did in September. While two or three individuals might be present simultaneously in the camp area, no real tendency toward flocking was observed at either the beginning or the end of the season.

In an adult male of July 29 the bill was yellowish brown, with tip of maxilla dusky; iris olive-brown; tarsus yellowish brown; toes grayish brown; testes 4×2.5; brood patch bare; weight, 28.3 g. In plumage (aside from the lores) it scarcely differs from the two adult White-crowned Sparrows (June 9 and 26) except in its duller-colored flanks (Buffy Brown rather than Cinnamon-Buff or Tawny-Olive). I can distinguish no tangible difference between the two forms in dorsal coloration, especially when allowance is made for the worn state of plumage in the July bird. The superciliary stripe is broad and continuous almost to the nostrils.

In two juvenile males of August 7 and in two males in first winter plumage (August 23 and 28) the lores are Pale Olive-Buff and more or less continuous with the superciliary stripe. These specimens are considered as probably

gambelii, although the distinction that Ridgway draws (1901: 331) between juveniles and immatures of *gambelii* and *nigrilora* scarcely seems to hold. The colors of the bare parts showed considerable variation: bill fuscous to brownish horn color, tip of maxilla generally dusky; iris dark olive-brown; tarsus and toes pale brownish gray to grayish brown, the toes in some cases a little darker. Weights, 25.6, 30.5 (August 7), 28.4 (August 23), 30.25 g. (August 28). The testes varied from about half the size of pinheads (August 7) to 1.25×.75 (August 23). In the specimens of August 23 and 28 the skulls are one-quarter and one-sixth granulated.

Rand remarks (1948b: 95) concerning *gambelii:* "Immatures in their first autumn plumage follow adults in the intensity of dorsal coloration, but otherwise appear inseparable from *leucophrys*."

At Churchill Taverner and Sutton (1934: 77) record both White-crowned and Gambel's Sparrows and intermediates as well; Grinnell and Palmer (1941: 53) likewise record both forms. Manning (1948: 24) found *gambelii* at Sandhill and South Henik Lakes and Tha-anne River. To the westward and northwestward, Preble (1908: 431) records the present species at Fitzgerald (Smith Landing) and Fort Resolution, from Fort Rae to Great Bear Lake, and on the Anderson River; Anderson (1913: 486), at Coronation Gulf. Preble (1911: 393) found it near Chipewyan (June 5), at Fort Resolution, and in the eastern part of Great Slave Lake. Reference to its occurrence at Hill Island Lake has been made in the account of the preceding species. Blanchet's mention (1926a: 74) of "white-throated sparrows" in the vicinity of Nonacho Lake possibly pertains actually to the present species. Clarke (1940: 61) records it from Nonacho, Artillery, and Ptarmigan Lakes, the upper Coppermine River, and the Thelon River. To the southward, it breeds at Reindeer Lake and Cochrane River (Buchanan, 1920: 254).

Zonotrichia albicollis (Gmelin), White-throated Sparrow.—On May 29, with a snowstorm blowing from the northwest, a White-throated Sparrow was collected while feeding on a refuse heap in the center of Churchill. It was bob-tailed, and so very dingy-looking that one could imagine its having spent the winter in a coal-bin!

There are several previous records of occurrence at Churchill (Preble, 1902: 121; Taverner and Sutton, 1934: 79). To the westward, there are records from as far north as Fort Rae, Great Bear Lake, and the lower Mackenzie River (Preble, 1908: 433). (In 1914, however, I failed to find the Whitethroat along the southern border of the Hudsonian Zone between Athabaska and Great Slave Lakes.) To the southward, the species has been found at Reindeer Lake (Buchanan, 1920: 254).

Passerella iliaca iliaca (Merrem), Eastern Fox Sparrow.—In its summer home the Fox Sparrow pushes northward to the very edge of the Barren Grounds, as far as the dwindling patches of trees and shrubs afford it suitable shelter. Here, however, it is neither common nor confiding. About the mouth of Windy River it was recorded on only 14 days, from June 5 to August 29; and on only three or four of these days were as many as two individuals noted. The records of approximately 20 individual occurrences may have been furnished by no more than half a dozen birds. The presence

of the species among spruces was recorded ten times; among dwarf birches, four times; and in the dooryard, once.

The song was noted on nine days from June 5 to 30 at Windy River, and possibly once at Josie's Bay on July 16. On June 15 a bird started singing 2 or 3 feet from the top of a 40-foot tamarack, the tallest tree in an extensive upland thicket of black spruce and tamarack, which formed the principal local habitat of the species. It presently mounted by several stages nearly to the top. On the spur of the moment I set down its song as follows: *Oh say, sweet muzizick, what're you doing here?*—though it may be close to desecration to represent such a fine production so nonsensically. (I well remembered how the birds of the Athabaska Delta, in years gone by, seemed to sing somewhat differently: *Oh this would be right pretty set to music.*) On June 17, in the same thicket, a Fox Sparrow was singing from the top of a 12-foot spruce. On the next day, on the same sort of perch, a bird threw its head well upward in singing. The call-note was definitely recorded only on June 13 and July 22. On the latter date an adult uttered an anxious *chek* among spruces and dwarf birches, as if its fledglings were abroad. For a time it perched on top of a spruce, punctuating its call with tilts of its tail.

To the eastward, Taverner and Sutton (1934: 79) note the Fox Sparrow as a rare summer resident at Churchill, May 30 to September 6, while Manning (1948: 24) reports it as common at Sandhill Lake. To the westward, it is recorded on Great Slave, Great Bear, and Artillery Lakes and on Slave and Anderson Rivers (Preble, 1908: 446). To the southward, Buchanan (1920: 357) found it at Reindeer Lake and Cochrane River.

Calcarius lapponicus lapponicus (Linnaeus), Lapland Longspur.—Although the Windy River and Churchill are both situated on the border of the Barren Grounds, the status of the Lapland Longspur is quite different in the two localities. Whereas Taverner and Sutton (1934: 80) consider it the most abundant nesting bird at Churchill, it is rather uncommon as a breeding species about the Windy River, where only about 39 birds were recorded during the season. On May 29, after eight days in Churchill, I noted half a dozen birds, including a male at a refuse heap in the center of the town. At Windy River from two to about half a dozen birds were seen nearly every day, June 2 to 12. They frequented sedge bogs as well as the hilly Barrens. During the first few days only males were recorded; but from June 7 on, females were in evidence. The birds associated to some extent with Hoyt's Horned Lark. They were confiding enough to approach within 10 feet of a human being. A tinkling song, heard at a distance on June 7, was reminiscent of a Bobolink's; it was the only song recorded during the entire season.

Most of these birds of early June may have been migrants, bound for more northerly breeding grounds, for after June 12 no more were noted for a couple of weeks. June 27 was a day of sleety snow, and the inclement weather seemed to bring into the dooryard more than the usual quota of avian visitors, including a female Lapland Longspur. It was perhaps the same female that came on the following day and was seen picking at an old caribou bone, with some fat or meat on it. On July 3 a male was noted on a near-by ridge in the Barrens.

The Longspurs, as true Arctic breeders, probably felt less at home on the low Barrens along the Windy River than on the comparatively bare, wind-swept summit of Josie's Hill, rising several hundred feet above Windy Bay. Here, on July 16, I encountered three or four individuals, including a male apparently carrying food in its bill; it called *tweer, tweer*—a slightly burry note. On August 8 I collected an immature bird from a flock of three on a hill in the Barrens along the Windy River. No more were identified during the rest of the season, although a few distant birds, possibly of this species, were noted on August 12 and 24.

In a male of June 7 the bill was corn yellow, with a fuscous tip; legs and feet nearly black. The specimen was superlatively fat, and weighed 36.6 g. Its testes measured 9×6 mm. In a juvenile female of August 8 the bill was light brownish, with a dusky tip; iris deep olive-brown; tarsus and toes brownish gray. It was rather fat, and weighed 29.8 g. The skull was not granulated.

There are summer records of the Lapland Longspur at Churchill, Button Bay, Hubbart Point, and south of Eskimo Point (Preble, 1902: 119); at Malaher, Boundary, Boulder, South Henik, Camp, Carr, Alder, Victory, Ninety-seven, Twin, Smoke, Baker, and Yathkyed Lakes and Tha-anne River (Manning, 1948: 24); at Tavane (Blanchet, 1930: 61); at Southampton Island and Fullerton (Sutton, 1932: 236); and at Somerset Island, Prince Regent Inlet. Arctic Bay, and Craig Harbour, Ellesmere Land (Shortt and Peters, 1942: 347). Hørring (1937: 119) reports it at numerous localities, from Pond Inlet and King William Island south to Chesterfield Inlet, Baker and Yathkyed Lakes, and Eskimo Point. Gavin (1947: 203) found it in the Perry River district. Preble (1908: 423) presents summer records from west of Liverpool Bay, Port Bowen, Felix Harbor, Port Kennedy, Franklin Bay, and Kent Peninsula. Preble (1911: 391) found the species at Artillery, Ptarmigan (Casba), Clinton-Colden, and Aylmer Lakes. Buchanan (1920: 252) reports it on migration at Reindeer Lake.

Plectrophenax nivalis nivalis (Linnaeus), Eastern Snow Bunting.—From May 21 to 31 the Snow Bunting was evidently the most abundant bird at Churchill, outnumbering the Horned Larks. Here they appeared daily in flocks of varying size, some of them numbering about 35 individuals or perhaps more. It was strange to see this bird of the Barren Grounds virtually taking the place normally occupied by the House Sparrow in towns—feeding along the roads, congregating at heaps of horse manure and other refuse, perching on boulders and houses, or lining up on the edge of the roof of the huge grain elevator 100 feet or more above the ground. They seemed inclined to move about less rapidly than the Horned Larks that fed in proximity to them. In hopping over a snowdrift, one of the birds twitched its tail up and down once or twice when coming to a pause; perhaps it also gave a little flirt of the wings at the same time. Among the notes heard were the following: a rapid, twittering *prrrrk* or *pirrrrik* on the wing, and *tyeu* (French pronunciation) while perching. At this season the plumage varied from the brown and white of winter to the black and white of summer.

At one point the railway embankment at the edge of the Churchill River is buttressed by a long pile of rocks. Here, on May 25, considerable numbers of Snow Buntings were seeking shelter from a keen northwest wind by enter-

ing crevices in the rocks. Any one walking along the railway track above would not be aware of the presence of the birds until they took alarm, popping out of the crevices and giving buzzing or twittering notes as they flew off.

Numbers of the birds were in the habit of congregating at a certain place on the shore of the river where piles of horse manure and straw had been dumped. Near by was a big discarded metal cage, with openings about 5 inches square; this was commonly used by the Buntings as a perch. On May 29 a Pigeon Hawk suddenly appeared at the open side of the cage and perhaps even went a little way inside it. But it secured no Bunting on this stoop; it flew off some little distance to perch on a signal tower. When I looked about for the Buntings, at first none were to be seen. Then a few appeared about the sides of the cage, and presently a good many more were seen cowering beneath an old mattress and other refuse material within the cage. They had made such successful use of this refuge at a critical time that I suspected they had had quite a bit of practice. After a few more moments the birds from the cage, as well as others that materialized from near by, took rapid wing out over the river in a flock numbering perhaps 35. They went high and seemed to disappear in the west. Another local enemy was a cat at the principal store in Churchill, that seemed to catch a Snow Bunting or a Horned Lark every now and then.

On May 31, at Duck Lake, where the plane stopped for refueling, a flock of about 25 was seen; the manager of the post, Mr. Flett, reported that the birds had been present for about a month. By this time the bulk of the spring migrants had apparently passed the Windy River area; on June 10 one or two were seen on the Barrens, and on the 11th one was collected on the snowy river bank. I saw no more till October, for the breeding range of the species evidently begins at an appreciable distance north of the southern border of the Barren Grounds. During the fall I noted only about 27 individuals, while others reported thousands.

On a trip from the Windy River to the upper Kazan River and return, September 17 to October 1, Fred Schweder, Jr., reported seeing "about a thousand" Snow Buntings per day, in flocks numbering up to 100 individuals. On October 5, a day of continuous snowfall at Windy River, with a light north-northwest wind, Charles Schweder reported a single bird in the dooryard and a flock of about 25 flying southward. (Traveling with a snowstorm seems characteristic of this species in the Northern States as well as on the Barren Grounds.) During the rest of the month, up to the 21st, Snow Buntings were noted by several of us on about half of the days, in numbers varying from a single bird to several hundred. During the last week of this period (which we spent at Simons' Lake), the ground was mostly bare. The birds frequented the Barrens and the open bogs, and a couple appeared on a sandy beach at Simon's Lake. I recorded no notes from them at this season. Charles Schweder reports the species as much less common hereabouts in the fall than in the spring. This suggests that when the fall migration gets under way, the birds are more inclined to head for the shores of Hudson Bay or other bodies of salt water than to move directly southward.

In an adult male of June 11, in summer plumage, the bill, tarsus, and toes were black; weight, 33.3 g. (quite fat); testes, 8×5; feathers about base of

bill stained reddish, probably from feeding on mountain cranberries. In an immature male of October 11 the bill was corn yellow, with fuscous tip; iris dark brown; tarsus and toes black; weight, 38.5 g. (very fat); testes, 1.5×1.25; skull one-third granulated; feathers about bill stained as in the other specimen.

There are summer records of the Snow Bunting from the following localities in the Barren Grounds: Chesterfield Inlet and Melville Peninsula (Preble, 1902: 119); Churchill—one record, July 22 (Grinnell and Palmer, 1941: 53); Southampton Island (Sutton, 1932: 242); Eskimo Point, Rankin, Chesterfield, and Wager Inlets, Repulse Bay, and Baker Lake in Keewatin, and elsewhere northward to Bylot Island (Hørring, 1937: 114); Somerset Island (Shortt and Peters, 1942: 348); Admiralty Inlet (Bray, 1943: 534); Lake Ninety-seven and (lower) Kazan River (Manning, 1948: 24); Perry River district (Gavin, 1947: 203); North Georgia Islands, near Hutchinson Bay, Franklin Bay, Port Bowen, Felix Harbour, Port Kennedy, Wellington Channel, and Banks Island (Preble, 1908: 420); Clinton-Colden and Aylmer Lakes (Preble, 1911: 390); Liverpool Bay, Baillie Islands, and Coronation Gulf (Anderson, 1913: 484); Lac de Gras and Artillery and MacKay Lakes (Blanchet, 1925: 53); Campbell Lake and Hanbury and Thelon Rivers (Critchell-Bullock, 1931: 17); and Aberdeen Lake (Clarke, 1940: 62). In Keewatin, at least, there appears to be a fairly broad strip of territory in the southern portion of the Barren Grounds where the Snow Bunting does not breed.

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Distribution of Marine Mammals to Florida Waters

Joseph Curtis Moore
Everglades National Park, Homestead, Florida

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Four thousand miles of coastline facing on two large seas makes Florida the most marine state in the United States. The Gulf Stream from its partial origin in the tropical Caribbean Sea flows close along the southern tip of the Florida peninsula, and sweeps northward along the east coast progressively farther offshore. Surely this stream induces some tropical marine mammals to visit Florida waters. It probably accounts for the little-known but apparently tropical dolphin *Stenella longirostris*, being seen in a school so large that the observer estimated their leaping kept a hundred dolphins in the air at a time. It may also explain the surprising number of beaked whales whose bones have been found on Florida beaches. The warming influence of this current also unquestionably affects the Florida distribution of manatees and West Indian seals. On the other hand, a southward counter-current along the Atlantic coast must be influential in bringing to Florida waters marine mammals from the north. An example is a prodigal hooded seal which came half-way down the Florida east coast. The North Atlantic right whale has been seen returning northward in this cool current off the Florida east coast in the spring. Independent of these currents is an apparently migratory phenomenon which brings spotted dolphins to Florida waters in summer and the common dolphin *Delphinus delphis* in winter. Influences of these currents, migrations, and the vast receptive coastline of Florida will doubtless enable alert naturalists to find species of marine mammals cast upon Florida shores additional to the twenty-one which can be reported now.

The present investigation originated as a study of the marine mammals of the Everglades National park and adjacent waters. Encouraged by Dr. Remington Kellogg of the United States National Museum, and by my seniors in the National Park Service, I expanded the scope of this work to that of a state list which is admittedly inadequate for such a vast coastline.

It does, however, provide a much-needed list of the species presently known for Florida waters, and also a key for identification of these forms. In addition, this work offers new information on distribution and natural history. Sherman (1937) published a list of the recent wild *land* mammals of Florida with additions in 1945, but there is no proper list of the recent *marine* mammals of Florida in print.

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To provide for the appraisal of records and observations from the collecting vessel of Marine Studios, Collins (letter, February 20, 1951) writes, "Our collecting vessel [has operated] from St. Augustine to Marineland [20 miles] at a distance of not more than twenty miles off-shore . . . from 1938 until 1942 and from 1946 until the present . . . the crew can distinguish *Tursiops, Stenella, Delphinus delphis,* and *Kogia* infallibly. . . . From April until September the collecting crew spend approximately 100 hours a month in the ocean, and from September until the following April, about 25 hours a month."

All localities mentioned in this paper are for Florida unless otherwise indicated.

MONACHUS TROPICALIS (Gray)—West Indian Seal

This tropical seal was abundant when white man first came to the West Indies, and as early as 1675 when Dampier (J. A. Allen, 1880: 708) observed them on the Alacranes, he remarked that the Spaniards often came there to slaughter them for their oil for illumination, and that Englishmen from Jamaica likewise came to slaughter for cargoes of this oil. The vigor with which sealers pursued their quest for oil had apparently brought this fine animal to the verge of extinction by the first of the twentieth century.

The earliest Florida record is that of Herrera (Vinten, 1943: 53), who in his account of Ponce de Leon's discovery of the Dry Tortugas Islands (lat. 24°10′ and long. 83°55′) on June 21, 1513, stated that a foraging shore party took fourteen seals. C. R. Vinten, coordinating superintendent of Southeastern National Monuments, contributes an interesting later record for this place (letter, February 21, 1951), "Then, in 1939 I was at Fort Jefferson [on the Dry Tortugas] when Everett P. Larsh of Dayton, Ohio, arrived in his yacht. He was once the army radio operator at Fort Jefferson, 1903-1908. Upon coming ashore one of his questions was, 'Are there still any sea lions around here?' As I knew the Ponce de Leon story, I . . . drew out the information from him that during his army tour there were several 'sea lions' on

nearby islands [of the Dry Tortugas], that he and some friends caught two in a net and screened the moat openings and kept them in the moat where they became fairly tame. . . ."

Of his experiences as a captive among the Indians of the Florida Keys 400 years ago, Fontaneda (1945, p. 26) remarks, "The common food is fish, turtle, and snails (all of which are alike fish), and tunny and whale; which is according to what I saw while I was among these Indians. Some eat sea-wolves; not all of them, for there is a distinction between the higher and lower classes, but the principal persons eat them." Sea-wolves is a literal translation of Fontaneda's (*op. cit.*, p. 66) "lobos merinos." Cabrera and Yepes (1940, p. 177) use the name "lobo marino" primarily in reference to the sea lion *Otaria flavescens*, and comment (*loc. cit.*), "Although the names sea lions and sea wolves are given generally to all the otarids, they are suited more especially to the type genus of the family. . . ." (my translation.) Regarding turtles and snails as fish, Fontaneda would hardly have hesitated to give the name for sea lion to any small pinniped he might have seen. There is no basis for presuming that any pinniped other than the West Indian seal might have been abundant enough to provide the keys Indians an established source of food, and we are forced to conclude that this is the animal to which Fontaneda referred.

J. A. Allen (*op. cit.*: 721) cites from a letter of R. W. Kemp to him concerning the seal, "Key West, Florida, April 29, 1878. . . . Some two or three years ago there were two seen near Cape Florida [lat. 25°04′ and long. 80°09′]. It was supposed that they had strayed from some of the Bahama Islands, as there are some few to be found in that vicinity. . . ."

Glover Allen (1942: 454) provides this interesting item, "Francis W. Taylor, President of the Warren Fish Co., of Pensacola, Florida, wrote to Dr. Harper in 1936 that on numerous occasions in the past, fishing vessels had brought these seals in to Pensacola alive. He understands that they are now to be found only on the Eastern Triangle Key, which has a protected bay inside, to which the seals resort, so that one must land in order to discover them. Here, he says, 'the fishermen tell me that one time there was a tremendous colony of seals . . . but it is their belief that the Mexicans have killed a great many, possibly all of them, for their oil. . . . I know of no seals which have been taken from the island in recent years. . . . In the early part of 1915 our vessel, the *Seminole*, brought six of these seals to Pensacola which were held in captivity here in one of our bayous for quite a long period of time. The bathers here seriously objected to their presence, and I believe that they were finally turned loose and remained in the bay for a while thereafter.'" The location of Pensacola is lat. 30°21′ and long. 87°31′.

An occurrence near Key West is chronicled by Townsend (1906: 583), "On February 25, 1906, a party of fishermen killed a West Indian seal about five miles from Key West, [about lat. 23°33′ and long. 81°48′] where the specimen is now on exhibition. It is a female, nine feet long and apparently quite old. The teeth are worn flat, the canines being worn down to the same level as the other teeth. When discovered the animal was promptly harpooned and then killed with a shotgun . . . the exhibiters called it a sea-lion until my

occurrence in the vicinity of Key West is recorded by Townsend (1923: 55), "A specimen was killed on March 15, 1922: near Key West, Florida, where it was identified by Mr. L. L. Mowbray, formerly of the Aquarium staff. . . ."

Gunter (1947: 289) has provided sight records which suggest that individuals of this speices had survived at least to 1932. Louis Rivas, University of Miami ichthyologist, informs the writer that a well-informed and responsible friend of his knows of the existence of a remnant of this species somewhere within its former range. This person desires only that the remnant should continue to exist, however, and will not divulge their location lest the seals be exterminated. A possible refuge exists within the former range of this species in the United States where it could be protected now. A number of the above seals might conceivably be captured and placed under the protection of the National Park personnel in the permanent refuge of Fort Jefferson National Monument on the Dry Tortugas. By retaining a breeding stock there for some years in partial captivity, it might be possible to build up a free herd native to the Tortugas which would return there to breed. With eventual cooperation in the Caribbean on this matter, then, possibly the animal could spread and gradually repopulate its former range.

CYSTOPHORA CRISTATA (Erxleben)—Hooded Seal

Gerritt S. Miller (1917: 121) reported an immature female hooded seal which was killed at Cape Canaveral, Brevard County, (lat. 28°27′ and long. 80°33′) and provides skull measurements of it. Mr. J. B. Butler of the Cape Canaveral Lighthouse Station presented the skin and skull of this specimen to the United States National Museum. Brimley (1946: 6) has published a record of an individual captured off Morehead, North Carolina, and sent in the flesh to the North Carolina State Museum on November 20, 1944. This was an immature male four feet long, weighing 71 pounds. He also mentions an earlier male specimen the skin and skull of which were obtained for the United States National Museum by L. B. Crank in August of 1910 at North Banks Beach, North Carolina. Since Bartlett (1927: 209) reports that these seals bear their young on ice east of Greenland and migrate south along Labrador every fall to the Grand Banks from where they begin to move back north again early in February, these very southern records apparently represent exceptional wanderings of individuals.

TRICHECHUS MANATUS LATIROSTRIS (Harlan)—Florida Manatee

A study of the contemporary distribution of the manatee (the writer, 1951b) recognizes as the ordinary range of this race, only the lower third of the Gulf coast of peninsular Florida (below latitude 27°), the Atlantic coast of peninsular Florida north to the mouth of the St. Johns River (lat. 30°30′), the rivers in this area and the Suwannee River in addition.

Lewis C. Watson, a charterboatman of many years of experience in Whitewater Bay and the Shark River now within the Everglades National Park, told me that he had noticed that manatees herd together during cold periods, and told me where I could observe it. Up until that time I had encountered a manatee only six times in perhaps seventy days afield in boats in the Park.

However, on January 26, 1951, the morning after the next sharp drop in temperature, two other members of the staff accompanied me to the place designated by Watson. There in the north prong of North River we found the manatees. They lay in turbid water four feet or less in depth in small loose groups, to judge mostly by the swirls of mud and water sent to the surface by the vertical propulsion of their tails. Some dodged about and hid in the clouds of mud stirred up by their own action. Others fled in fairly straight lines away, nicely followed by tell-tale series of up-boilings at the surface. Often we saw noses at the surafce momentarily for a breath; occasionally individuals fleeing directly before the boat became so frightened that they raised out of the water half their length. In one instance a pair stayed side by side fleeing before the boat. The up-boilings from their tail strokes rose in unison, and on two occasions they raised their noses to breathe simultaneously so close together that their sides must have been touching. Both appeared to be adults. In a half mile of the length of the north prong we saw the disturbances caused by about 35 manatees.

On the occasion of February 8, 1951, the morning after the next sharp drop in temperature, a second visit to this place by the writer led to a similar experience. This time a rough count tallied about twenty animals stirred up, but we tried to keep from unduly frightening the big beasts. Many undoubtedly escaped notice by lying still in the turbid water. Watson had, prior to all this, given me an estimate of forty-eight seen on his passage through the north prong after a cold snap, January 16, 1951. Hilburn Smith, another charterboatman in this area, told me of seeing a very large number of manatees there the morning after a sharp drop in temperature earlier in January of 1951. This phenomenon of aggregating during cold snaps has not been reported before for the manatee.

Five observations of very young manatees additional to those already reported by the writer (1951: 26) are now available. (1) M. Barnie Parker recorded his observation of an adult manatee with a 3½ foot young one in East River near where it empties into Whitewater Bay, April 28, 1950. (2) Louis Serrano of Miami told me on October 22, 1950, of having seen an adult manatee attended by a three-foot baby swim beneath him under the Fifth Street bridge over the Miami River in Miami on about October 1, 1950. He was painting on the bridge structure and the two animals passed within ten feet of him directly beneath on the surface swimming downstream. (3) On November 13, 1950, Serrano recorded an adult manatee with a calf about four feet long which appeared beneath the 17th Avenue bridge while he worked on it at 1:35 P.M. He made a sketch of the adult showing the locations of identifying scars in case he should see it again, but transfer to other work ended his observations. (4) The *Daytona News Journal* of March 9, 1949, printed a photograph of a "48-inch" baby manatee which had been taken from the Halifax River on March 8th at the Daytona City Dock. It had been seen behaving very feebly near the dock and attended by an adult which was nudging it about as though trying to get it to move. It died soon after being taken from the water. (5) District ranger Ralph D. Maxwell reported that on September 5, 1951, about 11:30 A.M. when he reached the

elbow of the south arm of the Shark River in the Everglades National Park, he saw an adult manatee breach wildly just ahead of his boat with a baby manatee less than four feet long at its side. This leaves December as the only month in which a very young Florida manatee has not been reported.

Fig. 1.—Right whale photographed from airplane off Daytona Beach. Note flaps of lower jaw on each side of upper, absence of dorsal fin. *News-Journal* photograph.

EUBALAENA GLACIALIS (Borowski)—North Atlantic Right Whale

In a discussion of the distribution of whales of this species J. A. Allen (1908: 313) alludes to their occurrence in Florida waters only in these words, "There is . . . scant evidence that they were ever numerous off Florida or around the Bermudas." These are the southernmost localities he gives for the range of the North Atlantic right whale. The economic demand for this animal's oil and whalebone resulted in its virtual extirpation by whalers by about 1750. For this animal to be observed with young in Florida waters at this time, therefore, offers hope to persons concerned with its survival, as well as confirmation of its distribution to these southern waters.

Kritzler (letter, November 9, 1950) writes, ". . . there were five *Eubalaena glacialis* in the region in March of this year. I saw three off Flagler Beach [lat. 29°28′ and long. 81°07′] and on the next day two off Marineland. The latter were probably the two which were seen off Daytona Beach the day before just about the time I was watching the other three at Flagler. The group at Flagler consisted of two adults and a half-grown calf. The other two were an adult and another half-grown calf." Figures 1 and 2 are photographs made by Jack Jesse of the two off Daytona Beach on March 6, 1950, and published in the Daytona News Journal, March 7th.

Photographs published by Burghard (1935) indicate, together with his account, another instance of a right whale with calf just off the Florida east coast. These were sighted off Hillsboro Lighthouse at Pompano (lat. 26° 16′) by charterboatman Frank Merritt and his son on March 25, 1935, at 9:00 A.M. Merritt harpooned the calf and played it until about 4:00 P.M. The adult remained close to the smaller most of the time in spite of many arrival. . . ." Skin and skull were mounted and held for sale. Then one more

rounds of high-powered rifle fire pumped into both animals. Merritt towed the calf into Ft. Lauderdale, and it was hauled up on drydock. A photograph of it there (*op. cit.*: p. 4) shows the species clearly. The calf's mouth is open showing that the baleen is only about 10 inches long, and hence that the calf was very young. There is no dorsal fin; the "bonnet" shows clearly; and the characteristic highly bowed side flaps of the lower jaw show well. Another photograph depicts the tail of one of the whales raised above the surface as it dived. There is a fairly deep central notch and rather straight trailing edges to the flukes.

BALAENOPTERA PHYSALUS (Linnaeus)—Common Finback Whale

Stranding or other occurrence of the finback whale on the Atlantic coast of the United States has been reported previously only as far south as North Carolina (Brimley, 1946: 7). A photograph published in the *Miami Herald* on May 26, 1950, of a large whale stranded on Ormond Beach, Volusia County, Florida, (lat. 29°17′ long.81°04′) is evidently that of a finback whale. A glossy print of this photograph shows backfin well caudad, throat grooved appropriately for the genus, and the under side of the flukes entirely white. The exposed right flipper is small, dark on the outer surface but with a light leading edge, and the belly is white and irregularly delineated from the rather dark gray of the sides and back.

Frank Essapian of the Scientific Department of Marine Studios witnessed

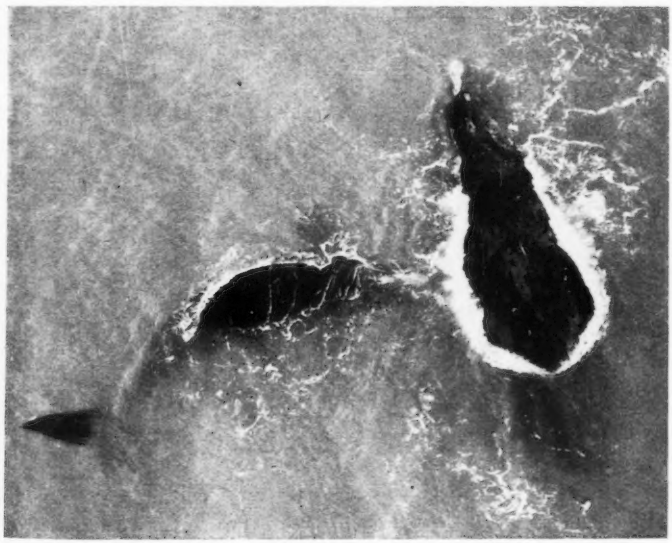

Fig. 2.—Right whale with calf off Daytona Beach March 6, 1950. *News-Journal* photo.

Fig. 3.—Common finback whale stranded at Ormond Beach May 23, 1950. Note white belly and throat grooves. Photo courtesy of Marine Studios.

this stranding and provides the following information (letter, March 27, 1951). "The whale was first reported stranded on a sandbar on May 23, 1950, some 200 yards from shore, approximately two miles north of Ormond Beach, Florida . . . the owner of the property opposite the stranded whale had . . . engaged a local wrecker service for . . . beaching, dismembering and selling the carcass. At this time the animal was still alive. . . . Later in the day, when I visited the scene again, a cable had been made secure around the animal's head and another around its tail, and with the help of the incoming tide, the body was being worked towards higher ground. By now the animal was dead . . . any calm and systematic study of the animal was precluded by the circumstances, as one had to buck the elements, the 'owners,' and the souvenir hunters. . . . Consequently only a few major measurements . . . were taken and a number of still photographs secured." Mr. Essapian kindly permitted the writer to publish the measurements which he obtained: total length, approximately 68 feet; span of flukes, 14 feet, 8 inches; greatest distance from leading edge to trailing edge of flukes, 2 feet, 10 inches; length of flipper, 8 feet; greatest width of flipper, 1 foot, 10 inches. These agree very well with measurements reported for this species by True (1904: 116) and indicate that this individual was quite large. Figures 3 and 4 are photographs of this individual reproduced through the courtesy of Marine Studios.

BALAENOPTERA BOREALIS Lesson—Sei Whale

In May 1919, a full grown male Sei whale stranded on the beach about 18 miles east of Jacksonville in Duval County (lat. 30° and long. 81°22′). When Miller (1924, a) published his account of this specimen, the species was known only from two other localities on the Atlantic Coast of the whole

North American Continent. This specimen was the first Sei whale to be reported for the United States and the first of the whalebone whales to be reported from Florida. Miller provides an elaborate series of skull and skeletal measurements, with the 53 photographs of skeletal parts, from this specimen.

BALAENOPTERA ACUTOROSTRATA Lacépède—Piked Whale

While there are a number of records of the piked whale for the New England States (Allen, 1916: 275-279), such records thin out rapidly to the southward, and end at Long Beach, New Jersey (Rhoads, 1903: 11) where one stranded in the fall of 1866. The ease of identifying the piked whale,

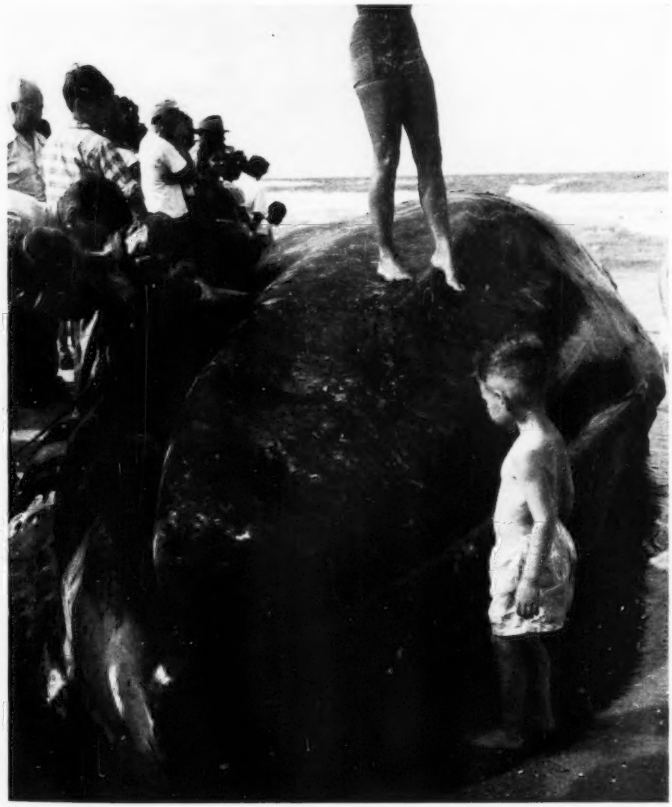

Fig. 4.—Looking the finback whale in the face. Ormond Beach May 23, 1950. Lower jaw much larger than upper. Photograph courtesy of Marine Studios.

and its preference for inshore waters (Allen, *op. cit.*: 275), suggest that rarity of reports may truly reflect rarity of occurrence in southern seas.

A 30-foot whale stranded on the bay (north) side of Long Key opposite Layton's fishing camp (lat. 24°51′ and long. 80°50′) in February of 1949. It was being attacked by sharks as it lay in shallow water. Frank Karcher towed it to Craig Key and measured it with a six-foot rule finding total length 32 feet and span of flukes 12. After several days on exhibit there, the whale was towed away and cast adrift. Barney Savant of Florida City showed the writer a glossy print of a photograph which he had taken of this whale and sent to the *Miami Herald* which published it on February 20, 1949. It shows the baleen on the left side to be white and the outer side of the flipper to have a white patch which identify this animal as a piked whale. Mrs. Mary Ikerd of Islamorada gave the writer a plate of the yellowish-white baleen with whitish fringes which someone had cut from this whale's mouth and given to her for a souvenir.

James I. Moore of Miami took some photographs of a whale skeleton for me on Big Pine Key, Monroe County, which showed this to be a whalebone whale. By generously driving me down there to see this skeleton, James Haeger of Homestead enabled me to identify it as that of a piked whale.

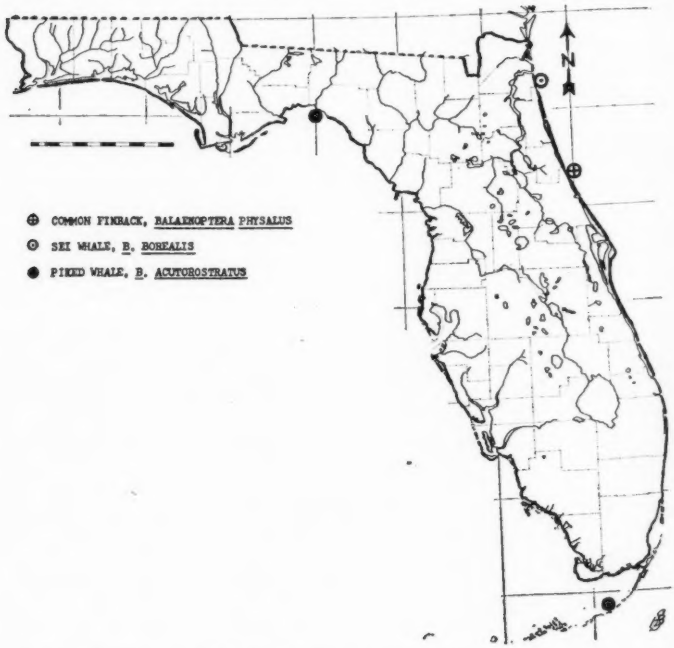

Fig. 5.—Chart showing localities of known strandings of finback whales in Florida.

James Cerruti of Big Pine Key had found this whale stranded and in an advanced state of decay on Annette Key just off the north end of Big Pine Key, and had towed it to a safer place where he gathered the bones after the flesh had rotted away. The writer believes this piked whale to be the same individual which had been cast adrift from Craigs. Cerruti permitted the writer to make the measurements of this animal's skull which appear in Table I.

Even more surprising than the piked whale's stranding in the Florida keys is an occurrence in the northern Gulf of Mexico. See figure 5. At Spring Creek, Wakulla County, a fisherman named Willey Spears charges admission to see a skeleton which he advertises as that of a prehistoric monster which science has been unable to name. He assisted the writer in making measurements of the skull (see Table I) which agrees well enough with those published by True (1904: 197) for the piked whale. Spears found this skeleton in 1940 in about four feet of water up a tidal creek about 30 miles east of Spring Creek (lat. 30°00′ and long. 83°52′). It was imbedded in firm mud.

These individual piked whales are of additional interest because they are the only adults from the Atlantic coast of North America which have been studied and reported upon. One tympanic bulla of each of these whales and one periotic bone and plate of baleen of the former have been deposited in the United States National Museum as 292258 and 292262. Handley's examination of these parts there confirmed identification of these whales.

The blue whale, *Sibbaldus musculus* (Linnaeus). Baughman (1946: 393) mentions the stranding of a blue whale on the Florida coast in May, citing Kellogg (1929) as the authority. The writer called this error to Mr. Baughman's attention, and he responded (letter, January 31, 1951) that in his notes a reference to the Sei whale had gotten among blue whale references and that his citation was incorrect. He asked me to correct this error here. The blue whale is apparently not known from Florida.

MEGAPTERA NOVAEANGLIAE (Borowski)—Humpback Whale

According to Townsend's study (1935, chart "D") of the ships' logs of whaling vessels, humpbacks were taken by whaling ships on six days in December and three days in January within 40 miles of the Florida east coast between latitudes 25° and 27°30′. The nearest other catch localities which he recorded were about the northeast shore of Haiti and among the Lesser Antilles.

PHYSETER CATODON Linnaeus—Sperm Whale

The United States National Museum formerly had skeletons of three sperm whales from the vicinity of the lighthouse at Cape Canaveral, Brevard County, (lat. 28°27′). Concerning these General O. E. Babcock wrote (letter of February 8, 1883, to Spencer F. Baird), "The keepers informed me that there are sixteen (16) within a few miles, and that they came ashore about the same time, and so far as they knew all were dead when they came ashore."

Stewart Springer collected a male fetal sperm whale on August 29, 1939, when it stranded on the beach at Englewood, Charlotte County (lat. 26°56′

TABLE I.—Piked whale skull measurements

	Big Pine Key mm.	%	Taylor Co. mm.	%
Greatest length of skull	1956	100	2286	100
Length of beak	1213	62	1448	63
Length of maxilla	1258	64		
Length of premaxilla	1353	69	1588	69
Ant. border foramen magnum to tip of beak	1779	91	2185	95
Ant. border f. magnum to top of occiput	504	26	591	26
Greatest breadth of skull	1029	53	1130	49
Breadth of beak at base	590	30	700	31
Breadth of beak at middle	398	20	457	20
Greatest breadth of maxillae post. to beak.	888	45	1028	45
Greatest breadth of premaxillae on beak	230	12	286	13
Greatest length of mandible (straight)	1815	93	2028	90
Greatest length of mandible (along outside of curve)	1930	99	2182	96
Height of mandible at condyle	189	10	205	9
Height of mandible at coronoid process	209	11	245	11
Height of mandible at symphysis	121	6	110	5

and long. 82°22′). He placed its skeleton in the Chicago Natural History Museum.

Harold J. Humm of the Oceanographic Institute of Florida State University kindly provided me with photographs of a right mandible which came from a sperm whale that stranded on the Gulf beach of Alligator Peninsula, Franklin County, (lat. 29°54′ and long. 84°20′) in 1938 or 1939.

The United States National Museum has two teeth of a sperm whale from Marathon (lat. 24°43′ and long. 81°05′), Monroe County, dated June 14, 1922, collected by L. F. Clark.

It is surprising that there are not more evidences of stranding of sperm whales in Florida. Townsend's study (1935, charts A and B) of the logbooks of whalers shows that sperm whales were taken in the Gulf of Mexico every month from March through July. Between Florida and the Bahamas, and just north of the Bahamas but still in Florida latitudes, whalers took sperm whales from April through September and also in November and December. The peak season for catches of sperm whales in these waters was April through July.

KOGIA BREVICEPS (Blainville)—Pigmy Sperm Whale

As late as 1941 there were only 26 published records known for the pigmy sperm whale in the whole Atlantic Ocean (Allen, 1941: 22). Two of these were Florida records. One was based on a lower jaw and a photograph in the United States National Museum from Jupiter Inlet, Palm Beach County, (lat. 26°55′ and long. 80°06′). The other rests on a photograph published in the January, 1940, issue of *Natural History* (McBride, 1940: 27) of a live pigmy sperm whale calf which had washed ashore in a storm near Marineland, Flagler County (lat. 29°43′ and long. 81°12′).

A *Miami Herald* story of November 26, 1949, described a small whale thought to be a blackfish, which stranded on St. Petersburg Beach, Pinellas County, (lat. 27°45′ and long. 82°50′) the day before and gave birth while stranded. A glossy print of the photograph showed this animal to have the pigmy sperm whale's characteristic undershot jaw. This is the first known occurrence of this whale in the Gulf of Mexico. Kritzler states (letter, Nov. 9, 1950) that the adult was 9½ feet long and the newborn calf 5 feet 4 inches long, weighing 181 pounds. The calf was sent to the Museum of Comparative Zoology, Harvard College, from Marine Studios.

Kritzler is of the opinion that pigmy sperm whales are more numerous than previously believed, and that their strandings are not reported more often because they are not usually distinguished from porpoises. He provides four further records:

1. An old male which washed ashore in a northeaster in January, 1948, at St. Augustine Beach, St. Johns County (lat. 29°52′ and long. 81°16′). "He was transported to the oceanarium at Marineland and died within twenty-four hours. . . . There was one deep puncture in him that may have been a bullet wound, but we never found the slug. Substantial portions of his dorsal thoracic region were saved for study by [Schollander] from Swarthmore."

2. An adult female stranded September, 1948, near Matanzas Inlet (lat. 29°43′ and long. 81°25′).

3. An adult female with calf September, 1948, near Crescent Beach (lat. 29°48′ and long. 81°30′). The adult's skeleton and the whole calf went to the United States National Museum.

4. An 8-foot female on April 18, 1950, at Matanzas Inlet, weight approximately 500 pounds.

For photograph of one of these, see figure 6.

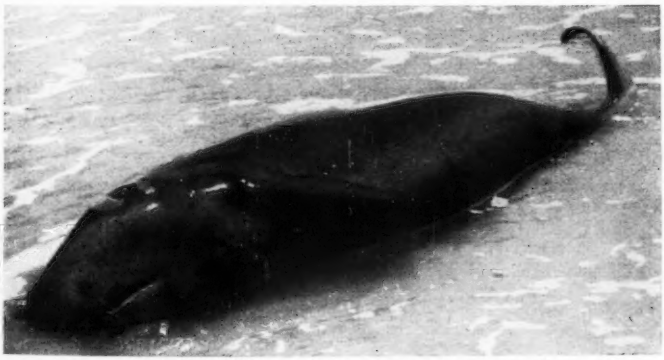

Fig. 6.—Pigmy sperm whale stranded on right side. Note undershot lower jaw and eye far removed from corner of mouth. Photograph courtesy of Marine Studios.

STENELLA PLAGIODON (Cope)—Spotted Dolphin

This appears to be the second commonest dolphin in Florida waters. Kritzler (letter, January 4, 1951) comments that this dolphin ". . . occurs chiefly in the summer but also during warm winters as close as 10 miles off shore. It is my feeling that water clarity may be a governing factor in the case of *Stenella*." Collins reports (letter, February 12, 1951) that this dolphin, ". . . has been captured ten miles off the coast in the vicinity of St. Augustine on June 29, 1949, August 3, 1950, August 4, 1950, April 13, 1950, and August 24, 1949. I personally have seen this species in December of 1949. . . ." Figure 7 shows one of these captives in the Marine Studios aquarium tank.

Barbara Lawrence (letter, May 17, 1951) and William E. Schevill observed individuals apparently of this species as well as *Delphinus delphis* from the Marine Studios vessel, "We saw the *Delphinus* five to seven miles off the beach at St. Augustine on March 16 [1951]; and on March 23 we saw a group of about eight *Stenella* about twelve miles off the beach. The crew said these were all cows and calves. They do use birds—I think gulls—as indicators when looking for porpoises, and they also consider that *Delphinus* have gone for the season when *Stenella* show up."

While collecting plankton in 1949 in the Gulf of Mexico off Cedar Key (lat. 29°05′) E. Lowe Pierce of the University of Florida observed spotted dolphins several times which the writer presumes were of this species. Pierce

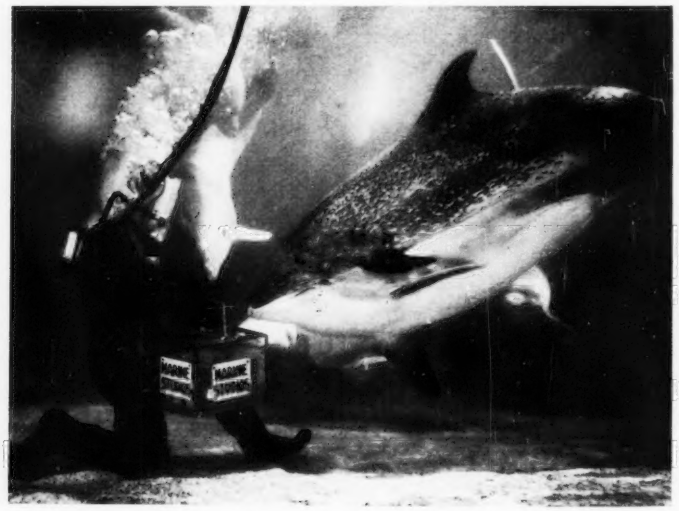

Fig. 7.—Spotted dolphin in captivity, one of several captured off St. Augustine. Note small whitish flecks on dark back and larger gray spots on white belly. Photographed with several bottlenose dolphins, courtesy of Marine Studios.

writes (letter, April 3, 1951), "The bottle-nose appears to be common around Cedar Key almost all year round. He frequents the inshore waters especially. The spotted dolphin appears usually in summer. I have not seen this dolphin in the winter in this locality. Also, I have never observed the spotted dolphin close inshore. In each instance in which I have seen them, they have been 12 miles or more offshore. At Cedar Key at this distance the water is clear and approaching normal sea water in salinity. I recall in one night trip about 40 miles southwest of Bradentown that a school of spotted dolphins followed the boat under the bow for a number of minutes. This was around midnight or later. We had to use flashlights to see them clearly." H. B. Sherman, who shared one of these observations, recorded that two individuals were seen close to the boat for several minutes, two miles outside of whistling Buoy off Cedar Key, May 22, 1949.

John DeWeese, Superintendent of Fort Jefferson National Monument (lat. 24°10′ and long. 83°55′), tells me that he sees spotted dolphins at the Dry Tortugas rather seldom, but more often while making routine trips between there and Key West. He has seen no large schools of pelagic dolphins in these waters such as he used to see in the Gulf Stream off Miami Beach when charter-boating there. DeWeese's boat captain, Joe Santini, told me of seeing "the mottled kind of dolphins" on the shrimping grounds just north of the Dry Tortugas during May of 1951 in 19 or 20 fathoms. There this species loitered about the commercial shrimping vessels to accept the fish being sorted out of the shrimp catches and tossed overboard.

James Higman, Marine Laboratory of Miami University, while studying commercial shrimp trawling in the Dry Tortugas "grounds" observed dolphins in mixed groups when the catch was hauled aboard and the trash fish thrown overboard each morning at dawn. He counted as many as 15 dolphins present one morning. Bottle-nose dolphins predominated in these groups, but spotted dolphins were observed among them on the four August mornings when there was light enough to make the distinction. Higman made these observations on August 7, 1951, in 15 fathoms, 1 to 5 miles northeast of the shallows of the Dry Tortugas, on August 8 to 11, 1951, in 13 to 15 fathoms in an area 16 to 25 miles north of Marquesas Keys between bearings of about 335° and 350°, and on July 27 and 28 in the latter area. Two spotted ones were seen definitely on July 27th. The common squid taken in the trawls, *Doryteuthis plei*, a small flounder, *Syacium micrurum*, and a mojara-like fish *Eucinostomus goula*, appeared to be especially favored by the dolphins; whereas the dolphins showed little relish for certain other species and refused some kinds. No notice was taken of whether the two kinds of dolphins differed in their preferences.

It is rather interesting that for the Texas coast Gunter's (1942: 268) reports of spotted dolphins are, ". . . beyond about 12 miles off shore . . ." and for the Louisiana coast Lowery (1943: 256) reported spotted dolphins, ". . . seen on numerous occasions twelve to twenty miles offshore from the mouth of the Mississippi River . . ." and that for Florida records, the distance offshore seems to be about the same. This fairly well establishes preference by these animals for the deeper, clearer, saltier offshore water.

Perhaps even more striking are the indications that this species performs an annual migration into and out of the waters of northern Florida. However, it is, apparently, quite possible that some of the above sight records are for the following species, *Stenella frontalis* (formerly *froenatus*) which Fraser (1949: 332) says resembles *Stenella plagiodon*.

The United States National Museum has skeleton, cast, and viscera of a specimen of *Stenella plagiodon* from Pensacola, Escambia County, (lat. 30°19′ and long. 87°12′), and a skull of this species from Miami, Dade County.

STENELLA FRONTALIS (G. Cuvier)—Long-snouted Dolphin

Glover Allen (1925: 59) reported on two skulls of this long-snouted dolphin picked up on Florida beaches, one in May of 1917 at Coconut Grove, Dade County, (lat. 25°43′, east coast), and the other in 1924 at Sebastian, Indian River County, (lat. 27°49′, east coast). These are the only records which indicate stranding of this species on the North American continent. This dolphin is pelagic and seldom strands. Most specimens have been taken at sea in the tropical Atlantic south of Florida latitudes (Fraser, 1950b).

STENELLA LONGIROSTRIS (Gray)—Long-snouted Dolphin

About 1930 while fishing just west of the Bahamas off Turtle Rocks (lat. 25°41′ and long. 79°20′), which is about 45 nautical miles off Miami Beach, Al Pflueger of Miami harpooned a dolphin of this species. It was swimming in a school of several thousand of its kind, he estimated. Just from their sporting leaps as they progressed, 100 would be in the air at any one time. They were not color-marked in any way but smooth gray more or less like the bottle-nosed dolphin. The harpooned animal was about six feet long, Pflueger said, and the others in the school seemed to be uniformly about the same. He removed the dolphin's head and kept it in formalin for a number of years, and finally gave it to the Department of Zoology, University of Miami, which lent it to me. The teeth exposed numbered 52 on each side above, 51 on the left side below, and 50 on the right below.

Cabrera and Yepes (1940: 296) point out that this is a form known almost entirely from the southern hemisphere: Cape of Good Hope, Australia, the Galapagos, and the province of Buenos Aires. Their description of the external appearance of this species seems to fit *Stenella plagiodon* but for the tooth count. Nelson (1899: 19) reported the present species at a north latitude of 21°30′ off the west coast of Mexico, "In the blue water . . . with a depth of over 40 fathoms . . . between the mainland and the islands these . . . were very abundant in schools of from 100 to 200 individuals."

STENO BREDANENSIS (Lesson)—Rough-toothed Dolphin

Miller (1924 b: 508) recorded a specimen of this dolphin from Tampa, Hillsboro County (lat. 27°56′ and long. 82°26′). Its skeleton is specimen no. 49628 in the United States National Museum, and was obtained by Oscar Tollin on March 22, 1902. According to Fraser (1949: 331) this species is found in the warmer parts of the Atlantic Ocean and Indian Ocean. Kellogg (1940: 69) mentions its occurrence in the Pacific Ocean near Japan, Hawaii,

and New Zealand. Handley and Patton (1947: 201) provide a record of a specimen in the United States National Museum from Norfolk, Virginia. Specimens of pelagic dolphins from seaport towns such as Tampa and Norfolk, with no further information as to their source are, of course, suspect of having been brought in by ships.

Guiana river dolphin, *Sotalia guianensis* (Van Beneden). True (1889: 19) says, "A skull recently purchased by the National Museum . . . I regard . . . identical with *S. tucuxi*. . . . It is said to have come from Florida, but the evidence is not entirely satisfactory." This must be the report of *Sotalia* in Florida to which Dr. Kellogg had reference in his letter mentioned by Gunter (1941: 447). Its occurrence in Florida waters remains unconfirmed after 60-odd years, and this species is not here considered a part of Florida's marine mammal fauna.

DELPHINUS DELPHIS Linnaeus—Common Dolphin

The United States National Museum has as specimen no. 267478 a skull of this animal picked up on the beach at Miami Beach, Dade County.

Collins (letter, February 12, 1951) contributes from Marine Studios, "From our records we have captured the common dolphin, *Delphinus delphis*, [off St. Augustine] on February 2, 1950, and January, 1951. It is seldom caught closer than ten miles from shore. It has been seen by us only during the winter." Another such record is given above with the account of the

Fig. 8.—The "common dolphin" *Delphinus delphis* showing shape and color markings of head. One captured off St. Augustine. Photograph courtesy of Marine Studios.

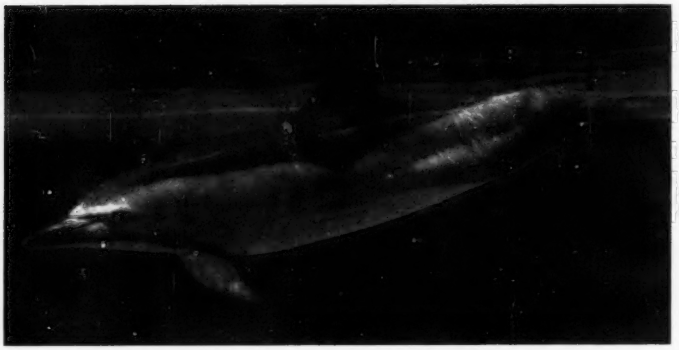

Fig. 9.—Full length of the common dolphin, *Delphinus delphis*, in captivity. Photograph courtesy of Marine Studios.

spotted dolphin. Figures 8 and 9 are probably the first published photographs of this animal captive and alive. While the common dolphin is considered to be present in all temperate and warm seas of the world, Fraser (1949: 328) found records of its occurrence in the English Channel and North Sea to be definitely related to the time of year. Since the above Florida records are also of this nature, study of a large number of records of its occurrence in the North Atlantic might reveal a complete seasonal shift of range.

Although this dolphin is regarded as pelagic in the western North Atlantic, it is interesting that a school of 30 or 40 ascended the Hudson River in October of 1936 and that two individuals, at least one of which was probably from that school, stranded dead at points 73 and 145 miles up the Hudson above the city of New York (Stoner, 1938).

TURSIOPS TRUNCATUS (Montague)—Bottlenose Dolphin

Figure 10 shows several of these animals in captivity.

This species appears to be migratory in England, Holland, and North Carolina but not Texas, according to Gunter (1942: 268). It is present in the marine waters of the Everglades National Park (Florida Bay, Whitewater Bay, and the Gulf of Mexico from East Cape Sable to Lostmans River) every month of the year. The cooperation of district ranger Ralph D. Maxwell, park warden M. Barnie Parker, and acting district ranger David E. Bogart, as well as other members of the park staff, has made available several recorded observations of these dolphins for every month of the year. The writer personally observed them in the park for all months but February. These records extend over the period of March, 1949, through August, 1951.

Hamilton (1941: 691) reported this species at Punta Rassa April 4, 1940, and I observed several there December 31, 1959, and off nearby Sanibel Island about a half mile from Sanibel's eastern tip on November 26, 1950. I also (1946: 58) reported this species seventy-five miles up the St. Johns

River at Palatka, Putnam County, and erroneously on up another seventy-five miles at Sanford. Jack Russell of Sanford (letter, November 1950) corrected, "This record of porpoises at Sanford is not definite." McBride and Hebb (1948: 112) mention this animal off the beach at Marineland, Flagler County. The writer has seen this animal several times in Biscayne Bay off Miami, once off 55th Terrace on December 10, 1949. E. C. Jones, Marine Laboratory of University of Miami, reported seeing lone individuals in Biscayne Bay August 20 and 24, 1951.

John DeWeese tells me that he often sees this species on routine trips between the Dry Tortugas and Key West, and that it occasionally visits the Dry Tortugas. During passage from the Dry Tortugas to Key West on June 5, 1951, the writer observed five groups of bottle-nose dolphins. The first three groups were approximately halfway between Rebecca Shoal Light and the Marquesas, and about three miles south of a line bisecting those two objects. The remaining two groups were encountered about five miles southwest of Key West. The smallest group was of two and the largest of at least seven animals. The boat captain Joe Santini told me that he fairly often encountered "the mottled kind of porpoises" (*Stenella plagiodon*?) on this passage as well as "these black ones" (*Tursiops truncatus*), but that the former were always met with between Rebecca Shoal Light and the Dry Tortugas. Charts show that the water where Santini reports seeing "the mottled

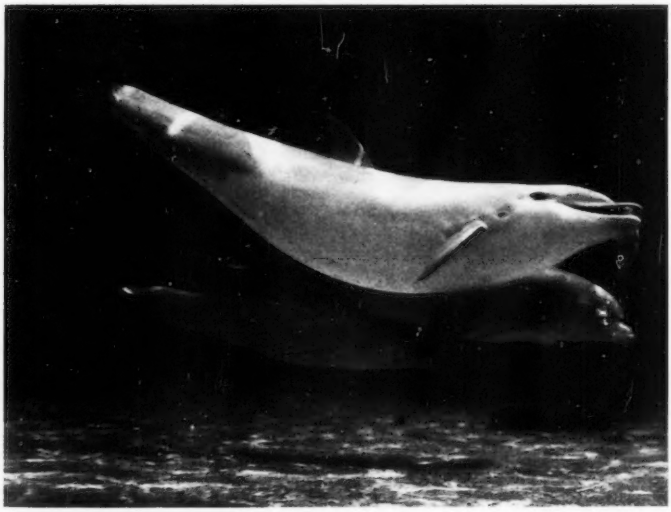

Fig. 10.—Bottle-nose dolphin, *Tursiops truncatus*, locally known as "porpoise" in Florida waters. Captives from near St. Augustine. The nearest one photographed whiter than it actually is. Photograph courtesy of Marine Studios.

kind" averages about 80 feet; whereas that on the remainder of the trip is seldom more than 45 feet deep and usually about 35.

During a passage to the Dry Tortugas on July 20, 1951, Robert Ginsberg, of the University of Miami, recorded for me a group of six gray dolphins 3 miles north of Rebecca Shoal Light and two more seven miles northwest of Rebecca Shoal Light. Between Loggerhead Key and Garden Key of the Dry Tortugas he observed three on the 25th. Superintendent DeWeese told him of three entering the harbor at Garden Key sometime between the 7th and 14th.

On the basis of the above records and the facts that Gunter (*loc. cit.*) found this species to be the common inshore dolphin of the Texas coast, Lowery (*op. cit.*: 256) of the Louisiana coast, and C. S. Brimley (1946: 2) of the North Carolina coast, it seems likely that the bottlenose dolphin occurs along the entire Florida coast, is the common dolphin of inshore waters here, and is the only one here occurring regularly in waters shallower than ten fathoms.

The bottlenose dolphin is sometimes seen at sea. Higman reported seeing a group of five of this species eleven miles off (east of) the Miami harbor entrance on August 14, 1951. The depth there is about 1200 feet.

McBride and Hebb (*op. cit.*: 115) report one instance of a captive mother bottlenose dolphin raising its still-born young to the surface on its snout as if to allow it to breathe, and another, whose older infant had died at night, which was found the next morning holding the little body to the surface. In an instance of a live birth observed, they report that although the infant dolphin swam to the surface for its first breath of air, the mother and one other adult female followed it in such a manner as to be instantly ready to raise it to the surface if it were not able to swim. These acts were all observed under the artificial conditions of captivity. The writer and acting district ranger David E. Bogart witnessed an example of similar behavior exhibited by a free, wild dolphin of this kind. The following account is taken from field notes written on the spot and altered very little:

November 3, 1950. 1:40 p.m. Approaching Whipray Channel through Whipray Basin, Florida Bay. Weather fair, no wind, and water still as glass, clear, and about six feet deep. We came upon an adult bottle-nose dolphin holding a baby dolphin to the surface on top of its head. The baby was dead and partially decomposed. It had been cut so nearly in half just back of the dorsal fin that only the skin, muscles of the abdominal body wall, and viscera held the body together. It looked as if this might be the work of a big barracuda. We circled the dolphin and its burden slowly, trying to approach without alarming it, close enough to take the baby. The dolphin steered its burden away from us, but made no violent motions. Periodically it withdrew from under the carcass and rose to breathe, submerged again, and took up the load on its head again. It swam slowly, keeping a constant upward pressure on the baby dolphin. The carcass floated rather high even when not supported by the adult. The top of the adult's head about the blowhole was noticed to be smeared with whitish, fatty material from contact with the decay-

ing body. Gently talking to the dolphin as we approached within about six feet, I slowly reached out an oar to pull the body to me. At this the adult backed away a foot or two under the water and made a few jerky motions with its tail and head, and perhaps flippers. As I drew the body to the side of the boat my eyes were on the adult. It moved very little, evidently watching intently. As I lifted the body out of the water, however, the adult dolphin moved quietly away. Several minutes later when we looked around for it, we could see no evidence of the adult's presence within a mile over the glassy water.

The eyes, anus, and umbilicus had been subject to special decay, as had, of course, the gaping severed portion. Bogart and I having recently shared an experience with a beaked whale which had been dead a known five days, agreed while inspecting the baby dolphin that it had been dead about three days. It measured 3 feet, 4 inches long; its flukes spread 12 inches without stretching; the dorsal fin measured 5 inches high; the flipper extended 8 inches from the anterior point of insertion. The teeth had not erupted but made very prominent lumps in the surfaces of the gums. The adult appeared to be about seven feet long, and its sex was not distinguished. According to McBride and Kritzler (1951: 254) and Gunter (1942: 271) births occur in this species in these latitudes from February through May. According to their data, also, the young dolphin which Bogart and I examined is about average length for one newborn. Our early November record therefore considerably extends the known season of births.

Good measurements of the speed of dolphins are seldom obtained. One of these animals swimming hard creates an impression of far greater speed than it can possibly attain. Fishermen commonly estimate the speed of this species between 40 and 75 miles per hour. Gunter (1942: 269) discusses swimming speed of this species. District ranger Maxwell and the writer obtained a measurement of the speed of *Tursiops* at 11:35 A.M. on March 6, 1951, in East River in the Everglades National Park. Meeting us in this small river a lone dolphin dodged by us close to the bank and sped down river. We turned and pursued, catching up until we were only 20 or 25 feet behind the fleeing animal. We were at full throttle, the course was straight, the water was six feet deep, and the dolphin kept its lead constant for 150 yards until the river widened. Then it doubled back, and we left it. While in the writer's experience *Tursiops* seldom runs straight away before a boat for such a distance in these waters, the circumstances of being alone, rather far from its usual haunts, and surprised in a narrow river doubtless explain this dolphin's run. Shortly after this chase an opportunity occurred for checking the speed of the boat with the same load still distributed the same. At full throttle we ran a charted distance of a straight nautical mile in 5 minutes, 36 seconds. Wind and current being negligible in both instances, the speed of the boat and hence that of the bottlenose was 10.7 knots or 12.2 m.p.h. Although I feel sure that it could have attained greater speed in a brief spurt, the dolphin in this case appeared to be rather frightened and running fairly hard.

TABLE II.—Skull measurements of bottle-nosed dolphin

	Florida Bay		Maule Lake	
	mm.	%	mm.	%
Skull length	464	100	501*	100
Rostrum length	259	55.9	281*	56.1
Rostrum width at base	115	24.8	121	24.2
Rostrum width at ½ length	79	17.0	78	15.6
Rostrum width at ¾ length	64	13.8	60	12.0
Preorbital breadth of supraorbs.	210	45.3	209	41.7
Postorbital breadth of supraorbs.	230	49.5	243	48.5
Zygomatic breadth	234	50.4	253	50.5
Max. proximal breadth pmx.	95	20.5	89	17.8
Tip rostrum to ant. nares (R)	309	66.6	345*	68.8
Tip rostrum to tip pterygoid (R)	329	70.9	356*	71.0
Height temporal fossa anteriorly (R)	63	13.6	69	13.8
Post. end toothrow to tip rostrum (R)	223	48.1	246*	48.2
Post. end toothrow to tip rostrum (L)	224	48.3	247*	48.3
Coronoid height mandible (L)	89	19.2	93	18.6
Post. end toothrow to tip mandible (R)	225	48.5	—	—
Post. end toothrow to tip mandible (L)	222	47.8	244	48.7
Teeth, upper	R25	L25	R23?	L23?
Teeth, lower	R22	L22	R—	L22

* 34 mm. has been added for missing tip of rostrum.

A State conservation officer presented the writer with a nearly complete skeleton of an adult of this species which he found on the edge of Maule Lake, a salt-water estuary a few miles north of Miami, in May of 1951. Jack Watson, of the U.S. Fish and Wildlife Service, towed a dead one to a protected place December 8, 1950, in Florida Bay to rot out for me. We examined it on the tenth and found it to be a male measuring:

Inches	mm.	
100½	2552	Total length
27	687	Width of flukes
9	228	Height of dorsal fin
17	432	Length of flipper
6¾	171	Greatest width of flipper
13½	343	Tip of snout to center of eye
2½	63	Center of eye to corner of mouth
15	381	Tip of snout to edge of blowhole
18	457	Navel to genital aperture
9½	242	Anus to genital aperture

The measurements of the skulls of these two specimens are presented in table II, and figure 11 illustrates them. The United States National Museum has three skeletons and a skull of the bottlenose from Florida, two of the skeletons from Tampa Bay.

GRAMPUS ORCA Linnaeus—Killer Whale

The Key West Municipal Aquarium has on display the skull of a killer whale which manager William Kroll told me came from an individual which stranded at Summerland Key, Monroe County (lat. 24°41′ and long. 81°26′)

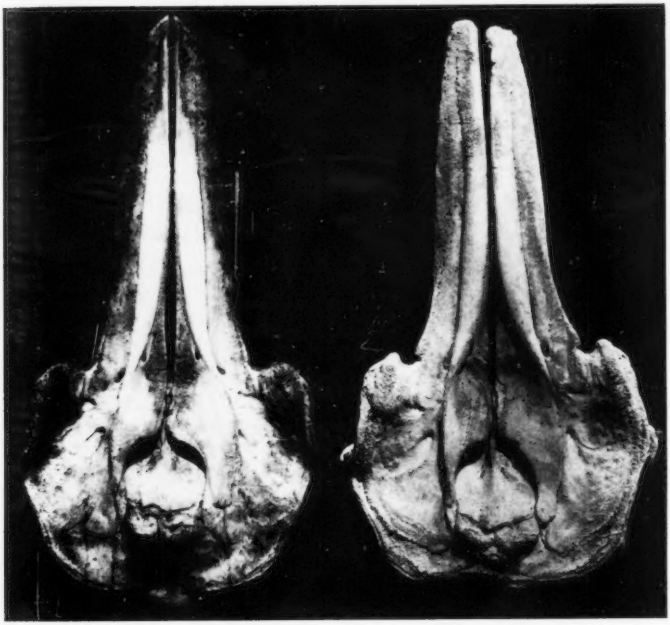

Fig. 11.—Skulls of bottlenose dolphin. Left from Florida Bay, right from Maule Lake just north of Miami. Dorsal aspect.

in about March of 1948. The University of Miami Marine Laboratory has one ramus of the mandible of this same individual in its collection. It seems that this killer whale is the sixth known to have stranded on the Atlantic Coast of North America (Ulmer, 1941b). It is the first killer whale to be reported for Florida.

Kroil courteously permitted the writer to take such measurements of the skull as were possible with its occiput partially imbedded in concrete, and the Marine Laboratory kindly lent the writer the ramus of the mandible. Measurements are presented in Table III. This skull shows alveoli of twelve upper teeth to a side, and the half mandible available also showed twelve.

The United States National Museum has a tooth collected from a killer whale in Hollaway Creek near Everglades, Collier County, by G. W. Storter December 26, 1921, and submitted by T. Menefee. This is the first record of the killer whale in the Gulf of Mexico.

Mowbray (1939: 214) published a photograph of a killer whale killed in the Gulf Stream between Miami Beach and the Bahamas by charterboatman Charles H. Thompson.

Back in about 1934, charterboatman Archie Cass of Miami Beach encoun-

tered a single killer whale off Hollywood (lat. 26°02′). Not recognizing it, he maneuvered near and harpooned it as it rose close to his craft. He said that the harpoon struck it behind the back fin and that the animal fought to get away for several hours. Unable to subdue it even with the aid of a rifle, he finally let it go. Having a movie camera aboard with about 200 feet of film, he got motion pictures of the animal. He told the writer it was about 30 feet long and had the characteristic whitish patch behind the eye.

Collins (letter, Feb. 20, 1951) contributes, "The killer whale is not abundant in these waters. Our crew saw a mammal in the spring of 1948 with a high, triangular-shaped dorsal fin . . . about fifteen miles off St. Augustine. There was no positive identification."

Gilbert Voss of the University of Miami Laboratory told the writer that he saw a single killer whale on the western edge of the Gulf Stream off

TABLE III.—Skull measurements of killer and false killer whales*

	Killer Whale		False Killer Whale	
	mm.	%	mm.	%
Breadth at centers of orbits	540	84	296	76
Greatest breadth of skull	640	100	388	100
Width in ant-orbital notches	292	46	173	45
Length of rostrum	535	84	273	70
Breadth of rostrum at midlength	279	44	152	39
Breadth of anterior nares	151	24	78	20
Length of maxillary toothrow	385	60	204	53
Length of mandible	840	131	482	124
Length of mandibular toothrow	403	63	208	54
Length of symphysis	179	28	82	21
Height mandible at coronoid process	233	36	124	62

* Note that in this table indices are of greatest breadth rather than greatest length. Killer whale specimen from Summerland Key. False killer whale specimen from off Bear Cut. See text.

Boynton (lat. 26°32′) in about 1939. In February of 1947 his brother Walter Voss encountered a group of three killer whales in the Gulf Stream about two miles off Boca Raton (lat. 26°21′). One of these came up close astern and rolled first on one side then on the other to look at the propeller of Walter Voss' charterboat with first one eye, then the other, from a distance of a few feet. Gilbert Voss also told the writer that captain George Sheaf saw killer whales several times in about 1934 off Palm Beach in the Gulf Stream (lat. 26°43′) and obtained some excellent photographs of them close aboard, which Voss himself has seen.

PSEUDORCA CRASSIDENS (Owen)—False Killer Whale

The first record (Miller, 1920: 205) of the false killer whale for the whole North American continent came from the shore of Biscayne Bay near Princeton, Dade County (lat. 25°35′ and long. 80°20′) where in 1918 L. S. Chubb found a nearly complete skeleton and three separate lots of teeth. He sent these to the United States National Museum, and Miller considered that these probably represented three individuals. Subsequently Brimley

(1937: 73) recorded a single specimen which stranded near the Hillsboro Lighthouse near Deerfield, Broward County (lat. 26°15′ and long. 80°06′), prior to May 5, 1922.

Al Pflueger of Miami placed a partial skull of the false killer whale in the collection of the Department of Zoology of the University of Miami. This came from a small individual which was harpooned from John Wentworth's charter boat about 5½ miles off Bear Cut, Dade County (lat. 25°44′ and long. 80°03′), where it was swimming in a large school of its kind including individuals estimated to be 20 feet long. Measurements of this skull are presented in Table III.

Collins reports from Marine Studios, (letter, Feb. 20, 1951) "We have nothing in our records concerning the false killer whale's appearance in our waters."

The photographs accompanying Donnelley's (1937) account of an encounter with a whale appear to justify calling it a false killer whale. Wilfred H. Osgood so identified it for Donnelley from the original photographs. Donnelley, Hunter S. Marston of New York and charterboatman Frank Seabrook encountered this lone whale about three miles off Jupiter Lighthouse (lat. 26°57′) on the Florida east coast in 11 or 12 fathoms of water in fair, rather calm weather on March 15, 1936. They hooked a 2½ foot bonita on a stout line and maneuvered in such a way as to drag this bait before the cetacean. It took the bait and soon broke their line. It jumped clear of the water and charged about near the boat so actively that the fishing party fled. One of Marston's photographs shows the big delphinid in profile rising on a leap which apparently would carry it clear of the water.

Pflueger, who has had long experience with marine animals particularly in the Gulf Stream off Miami, insists that the false killer whale is more numerous than the pilot whale there.

GLOBICEPHALA MACRORHYNCHA (Gray)—Pilot Whale

If one were to estimate the relative numbers of the several species of cetaceans in Florida waters by counting those which strand upon its shores, the pilot whale would easily lead. However, it is well known that this animal has a special tendency to become stranded in groups, sometimes very large groups. Figures 12 and 13 show stranded individuals near Marineland, and figure 16 shows the distribution of their known strandings in Florida.

According to Henry G. Frampton (*Miami Daily News*, July 3, 1933) he and Al Pflueger, Sam Cass and Archie Cass of Miami, and Leo Bishop of Homestead, piloted by Coleman Irwin of Flamingo, visited the site of a mass stranding of pilot whales on July 2nd at the southernmost point of the mainland of Florida which has since become part of the Everglades National Park. The whales were distributed for seven miles along the shallow marly shore from East Cape Sable east to Cormorant Point, about three miles west of Flamingo. The greatest concentration was along about 1,200 feet of shore at a place locally known as Sawfish Hole near Slagles Ditch. Here sprawled and rotting on the beach were sixty-six of the pilot whales lying head to tail along the high water line of the beach, all but two facing east. Others could

Fig. 12.—Pilot whale of October 7th stranding. This one is lying on its right side, its left eye showing just beyond the corner of the mouth. Color mark on throat shows faintly. Photograph courtesy of Marine Studios.

be seen scattered singly or in groups of four or five as far up the winding shore as the eye could see. The stranded whales were estimated to number more than two hundred. The largest whale measured 25 feet in length and many others measured 20 to 22 feet long. Turtle egg hunters on the beach saw no pilot whales on June 8th, and Coleman Irwin and his brother first noticed them about June 12th; so, apparently the stranding took place between those dates. The moon was full on the eighth. Irwin said that several pilot whales had stranded there similarly a few years before. Frampton's account was considerately made available to the writer from an old scrapbook by John M. Goggin of the University of Florida. Al Pflueger collected a skull from this lot and eventually presented it to the Park. Measurements of this skull are presented in table IV.

M. Barnie Parker, veteran warden in the Everglades National Park, provides from his log a record of four pilot whales stranded and dying on Northwest Cape Sable, May 17, 1945. He towed one out into deeper water, he says, but it only returned voluntarily to the beach. He also reports one on April 26, 1945, floundering alone in shallow water at the west end of Tarpon Bay, eight miles up the Shark River. He approached this one and prodded it with a paddle without getting much response.

TABLE IV.—Skull measurements of Globicephala macrorhyncha

	Key Biscayne		U. Miami*		Cape Sable*		Cape Sable*		U. Miami*	
	mm.	%	mm.	%	mm.	%	mm.	%	mm.	%
Total skull length	663	100	646	100	630±	100	585	100	585	100
Rostrum length	333	50.2	328	50.7	320±	50.8	288	49.2	283	48.4
Basal rostrum width	256	38.6	277	42.9	243	39.6	231	39.5	218	37.3
Rostrum width at midlength	221	33.2	233	36.1	210±	33.3	188	32.1	159	27.2
Breadth preorb. angles of supraorb.	453	68.3	477	73.8	—	—	364	62.2	364	62.2
Breadth postorb. angles of supraorb.	481	72.5	501	77.5	451	71.6	394	67.4	392	67.0
Least supraorbital breadth	438	66.1	460	71.2	409	65.0	349	59.6	358	61.2
Zygomatic breadth	491	74.0	501	77.5	451	71.6	398	68.0	393	67.2
Greatest breadth premax. proximally	172	25.9	179	27.8	—	—	158	27.0	143	24.4
Greatest breadth premax. distally	227	34.2	246	38.0	—	—	184	31.4	173	29.6
Width premax. at midlength rostrum	223	33.6	234	36.2	—	—	177	30.1	159	27.2
Tip rostrum to ant. nares (R)	452	68.2	449	69.4	—	—	388	66.3	388	66.3
Tip rostrum to tip pterygoid (R)	428+	64.6	428	66.3	—	—	387	66.1	387	66.1
Length temp. fossa (mesiad) (R)	140	21.1	142	22.0	126	20.0	105	18.0	112	19.1
Depth temp. fossa (ant.) (R)	93	14.0	80	12.7	86	13.6	74	12.6	74	12.6
Alveolar length max. toothrow (R)	160	24.2	188	29.1	—	—	140	23.9	138	23.6
Alveolar length max. toothrow (L)	163	24.6	180	27.8	—	—	145	24.8	139	23.8

* The University of Miami specimens are un-labeled material in the Department of Zoology collections, presumed to be of local origin. The smaller Cape Sable specimen is the one collected by Pflueger; the larger was brought in by a fisherman in 1950.

Just northwest of the present Park area in 1896 Oscar Tollin obtained a skeleton and three additional skulls of pilot whales from Pavilion Key (lat. 25°42′ and long. 81°21′) where a group of eleven had stranded. The eleven were considered to be full and half-grown females and one immature. The four specimens obtained are nos. 37261 to 37264 respectively in the United States National Museum.

A column in the *Miami Herald* records that just south of the Park on April 29, 1942, a group of twelve pilot whales came ashore at the southwest end of Plantation Key (lat. 24°57′ and long. 80°35′). The writer identified these from several good photographs on display in a Plantation Key tavern.

Jack Watson of the U. S. Fish & Wildlife Service took the writer to see a 9½ foot blackfish which had stranded on the Florida Bay side of Vaca Key, (lat. 24°43′ and long. 81°05′) during the night of July 28, 1951. It died sometime on the morning of July 29th and when the writer saw it the following day, it had been adrift and had had several roughly circular slabs of blubber 12 to 14 inches in diameter bitten away. The flukes and other easily accessible parts of the body had also been bitten away, presumably by sharks. The blackfish had seven upper and eight lower teeth on the right side. On August 1, 1951, Jack Watson found two more blackfish about the same size stranded on Harbor Key Bank at the north end of Big Spanish Channel (lat. 24°50′ and long. 81°05′). He thought their condition at that time indicated that all three animals may have been of the same group and stranded at the same time.

Other Florida records include the stranding described by Kritzler (1949) of a group of 46 individuals 8 miles north of Marineland on October 7, 1948 (lat. 29°43′ and long. 81°25′). When he saw them early that morning, at most a few hours after they had stranded, "The surf was moderate, the sky

Fig. 13.—Stranded pilot whale struggles as rising tide laps about blowhole of inert companion. Both animals are on their right sides. Two of 47 stranded October 7, 1948. Photograph courtesy of Marine Studios.

overcast. . . . There had been no storm. . . ." All lay on their sides because of their shape. Only one had drowned, but the next tide drowned about half of the group. The largest male was just less than 20 feet long and the largest females were as much as 15 feet long. The group was about evenly divided as to sex. The smallest individual was a male about 7½ feet long, and none of the females were in milk. None had any abrasions which would indicate that they had been tumbled ashore by a heavy sea. All lay quietly while the tide was out, but when it came back in, and the water rose around them, they thrashed about violently, apparently in effort to get back into deeper water. This only sank them into the soft sand. They swallowed and regurgitated quantities of sea water, and drowned as the water rose above their blowholes.

Kritzler (letter, January 4, 1941) mentions a group of about thirty pilot whales which stranded, ". . . either at Daytona or at New Smyrna . . . sometime during the winter of 1946-47."

LeRoy Childress of Miami picked up the skull of a pilot whale on the ocean side beach of Key Biscayne, Dade County, near its southern end (lat. 25°04′ and long. 80°09′) sometime in the 1940's. It was in good condition, and measurements of it by the writer are presented in table III.

On Porpoise Key, Monroe County, (lat. 24°43′ and long. 81°21′), James Cerruti, formerly of Big Pine Key, picked up a small pilot whale's skull in the late 1940's, which when seen recently by the writer, was in a somewhat weathered condition.

Tom Wood of Sanibel Island told the writer of seven pilot whales which came ashore in the pass between Sanibel and Captiva Islands in July of 1949 (lat. 26°29′ and long. 82°11′). Fishermen towed two of them off into deeper water, he said, but the whales only returned voluntarily to the beach.

In the United States National Museum are two skeletons and a skull of pilot whales, nos. 22570 to 22572 respectively, obtained in February, 1887 from Osprey, Sarasota County, (lat. 27°12′ and long. 82°30′).

From the Museum of Comparative Zoology at Harvard University, Barbara Lawrence writes (letter, May 17, 1951), ". . . I can give you a record of *Globicephala*, of which we have two specimens from a school of five stranded seven miles south of Jupiter, Florida, in the late autumn of 1920." This is lat. 26°50′ on the Atlantic coast.

The *Miami Herald* carried an account on March 15, 1946, of twenty-seven "killer whales" which were stranded at Pass-a-grille, Pinellas County, (lat. 27°40′ on Gulf coast), the Thursday before. On April 21, 1950, the *Miami Herald* printed a photograph of a small whale which had stranded at Melbourne, Brevard County, (lat. 28°05′ on the east coast), that week, apparently killed by a ship's propeller. A glossy print showed this to be a female pilot whale.

The museum of the Florida Geological Survey at Tallahassee has a skeleton of *Globicephala* mounted for display. This is one of five individuals stranded near Shell Point, Wakulla County (lat. 30°05′ and long. 84°27′), on June 22, 1932.

On November 24, 1950, the writer picked up the fused cervical vertebrae of a cetacean at the foot of the beach on Sanibel Island, lat. 26°25′ on the

Gulf coast. On June 4, 1951, W. E. Dilley and the writer picked up two more sets of cervical vertebrae and a caudal vertebra at the ruins of the old Carnegie Laboratory on Loggerhead Key, Dry Tortugas (lat. 24°10′ and long. 83°55′), which are probably evidence of a stranding there on the Dry Tortugas. C. O. Handley, Jr., identified all these vertebrae as of *Globicephala* (letter, August 1, 1951).

Hamilton (1941: 791) observed pilot whales swimming about in the bay at Fort Myers Beach, Lee County (lat. 26°20′ on Gulf Coast) on April 5 and 6, 1939. "One lot of seven individuals swam directly beneath the motor bridge, and it was possible to observe them clearly. I estimated their length from 14 to 18 feet. . . . This species occurs in the Caloosahatchee River several miles above Fort Myers."

Albert Schwartz of Miami told me of seeing a school of about a dozen pilot whales in Biscayne Bay about 9:15 A.M. on May 8, 1951. They were swimming east about two miles off the Goulds Canal, (lat. 25°36′ and long. 80°20′). Live pilot whales going about their ordinary affairs are apparently not often seen. Collins (letter, February 20, 1951) of Marine Studios, states that, "Pilot whales have not been observed by us except on the occasions of their strandings."

The above records show that pilot whales are known in ten instances to have been present in Florida waters during the months of March through July. An additional occurrence is mentioned for October, one for late Autumn, and one for winter. This suggests that the pilot whale's occurrence

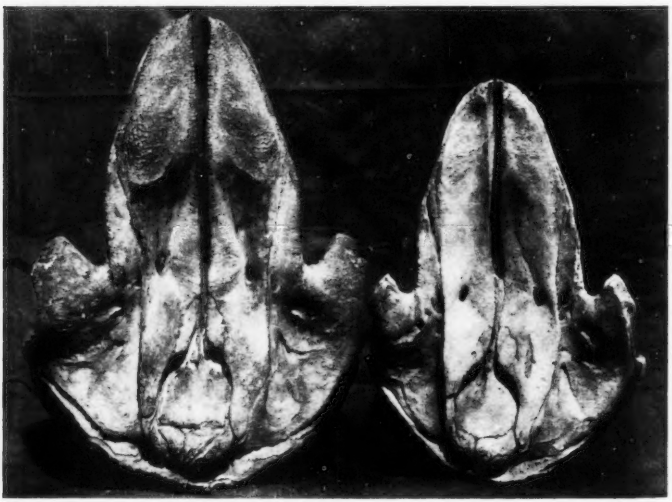

Fig. 14.—Skulls of adult pilot whale from Key Biscayne and young pilot whale from near Cape Sable in 1933 stranding. Dorsal aspect, displaying the lateral expansion of the forward portion of the premaxillae.

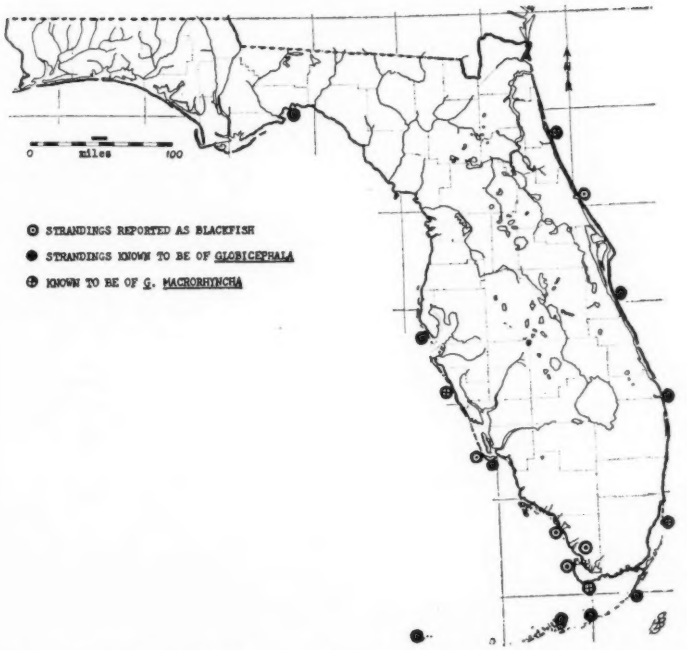

Fig. 15.—Chart showing distribution of known strandings of pilot whales in Florida.

in inshore Florida waters—and/or its strange tendency to strand—is seasonal, that the species is a migratory one here. Available dated stranding records from these latitudes in Texas (Gunter, 1946: 375) are for May 1940 and September 5, 1945 and in Louisiana (Lowery, *op. cit.*, p. 257) August 5, 1940. These support the above suggestion but extend the season. Figure 15 shows Florida strandings of blackfish to have been widely distributed.

Fraser (1950a: 59) shows that *Globicephala brachyptera* of Cope is a synonym of *G. macrorhyncha* (Gray) and (p. 52) that True placed the three above-mentioned Osprey specimens in this species. Measurements of our Cape Sable and Key Biscayne specimens (table III) agree well with True's (Fraser, 1950a: 55) of those from Osprey. These specimens agree also closely in the diagnostic lateral expansion of the premaxillaries with Fraser's (1950 a, pl. V, fig. 1) photograph of Gray's *macrorhyncha* type. See Figure 14.

MESOPLODON EUROPAEUS (Gervais)—Gulfstream Beaked Whale

Two of the five previously reported specimens of this extremely rare whale have come from the Florida coast. One of these was alleged to have come from one of three whales stranded on St. Augustine Beach, St. Johns County

(lat. 29°55′ and long. 81°17′). Ulmer (1947: 185) discovered this skull in a Catholic Academy in St. Augustine about 20 years later in 1944 and measured and photographed it.

In 1935 a salvager of shipwreck lumber noticed the carcass of a small whale on the rocky, ocean shore of Key Largo, Monroe County (lat. 25°15′ and long. 80°20′). Upon learning of this several weeks later, Al Pflueger of Miami visited the place and found the skeleton clean but scattered. He salvaged the skull and sent it to the American Museum of Natural History, evidently with its locality described as "middle Key Largo." Raven (1937: 7) provides measurements of this skull, with locality erroneously indicated as "Middle Key, Florida," and inexplicably ignores the specimen entirely in the remainder of his paper.

George G. Goodwin informed the writer of the presence of a skull of this whale in the American Museum of Natural History (letter, March 21, 1951), "The skull of *Mesoplodon,* A.M.N.H. no. 135639, is one we received from Albert Schmidt, Midway Colony, Melbourne, Florida. It is accessioned as November 3, 1939. I don't find any correspondence. . . . The only entry in the catalogue for A.M.N.H. no. 135639 is *Mesoplodon europaeus,* Florida, Albert Schmidt, skull only." To my letter explaining the importance of this specimen, Albert Schmidt responded (letter, April 19, 1951), "The skull of the small whale that I sent to the American Museum of Natural History in 1939 was found on the shore of the ocean beach about two miles south of Melbourne Beach [lat. 28°02′] in the spring of 1939, on top of the sand, after a storm." This exceedingly interesting record appears to be the sixth instance known to science of the occurrence of this rare whale. Since three of these are recorded from Florida where there has been little attention given marine mammals, it seems likely that alertness to this of Florida's seashore naturalists may quite possibly produce further specimens and information about this animal of which at present almost nothing is known. See figure 16 for a distribution chart of the known Florida strandings of this whale.

For illustrations of this species, Raven (*op. cit.*) provides a hazy photograph of the ventral side of a stranded specimen in the flesh, and photographs and/or drawings of: skulls (3 views), mandible (2 views), sternum, and skeleton of the right flipper. True (1910, pl. 41, figs. 1 & 2) provides a dorso-lateral and a lateral view photographs of an animal in the flesh. True further provides photographs of: skulls (4 views), mandibles, representative vertebrae, sternum, skeleton of right flipper, stomach, lungs, and perineum.

ZIPHIUS CAVIROSTRIS G. Cuvier—Goose-beaked Whale

While this whale is of world-wide distribution, it is so rare that very few naturalists have ever seen one in the flesh. I can find published photographs of only three of these in the flesh, two in True (1910, pl. 41, figs. 3, 4). Illustrator's renditions of this animal have, I believe, been uniformly misleading in regard to facial profile, shape of mouth, and location of eye with reference to mouth. This will now probably be corrected because of the excellent photographs published by Hubbs (1946: 249).

Since only six specimens of the goosebeaked whale have been previously

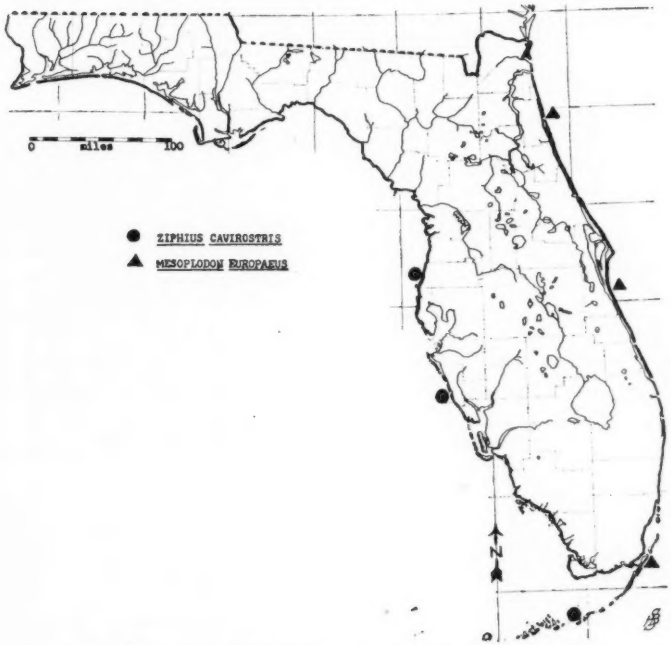

Fig. 16.—Chart showing Florida distribution of goose-beaked whale, *Ziphius cavirostris*, and Gulfstream beaked whale, *Mesoplodon europaeus*, in Florida waters as suggested by strandings.

reported on the eastern coast of North America (Ulmer, 1941a: 119 and Handley and Patton, 1947: 206) it is exceptionally interesting that four more records are now available from this one State. The only previous record for Florida is a note—unsubstantiated by a specimen—from the unpublished diary of W. J. Hoxie, ". . . that a *Hyperoodon vastratus*' [probably *Ziphius cavirostris*], a female, length 20 feet, containing a foetus, was found at Canaveral, Florida, August 21, 1888." (Ulmer, 1941a: 120).

(a) An adult male of this species came ashore on the ocean side of Conch Key, Monroe County, (lat. 24°47′ and long. 80°53′) on August 20, 1950. Residents of Conch Key told me that porpoises appeared to be attacking it repeatedly when it first came into shallow water. It came on in to shallower water until it grounded, and then it thrashed about for an hour or so before it died. Among the villagers of Conch Key this aroused great curiosity and speculation as to the creature's identity. Dale Doolittle, a commercial fisherman living there, towed the whale around to the lee side of the key. Having some slaughter-house experience and some curiosity about the animal, he cut it open. When I talked to him five days later, he said it had

TABLE V.—Skull measurements of Ziphius cavirostris

	a mm.	a %	b mm.	b %	c mm.	c %	d mm.	d %
Greatest length	952	100	810	100	910	100	768	100
Greatest height	467	49			465	51	368	48
Breadth across centers of orbits	500	53			493	54	431	56
Zygomatic breadth	524	55			511	56	455	59
Breadth of occipital condyles	157	17	134	17	140	15	132	17
Length of rostrum	493	52	435	54	491	54	444	58
Width of rostrum at base	265	28	290	27	239	27	198	26
Width of rostrum at mid-length	110	12	94	12	89	10	82	11
Depth of rostrum at mid-length	90	10	63	8	90	10	58	8
Greatest length of right mandible	878	92			839	92		
Depth at right coronoid process	164	17			157	17	124	16
Length of vestigial right toothrow	510	54			417	46	346	45
Length of mandibular symphysis	161	17			182	20	152	20
Depth of mandible at angle	61	6			54	6	51	6
Greatest ant.-post. diam. rt. tooth	39	4						
Transverse diameter right tooth	38	4						
Greatest length right tooth	60	6						

a penis about 3½ feet long, slender and tapering like that of a bull. The testes were like grapefruits, he said, indicating with his hands a sphere of about 5 inches in diameter. When the animal was fresh, he said, the color of its back was very dark gray with white spots like those of a spotted ray. The belly was lighter. He had measured its total length by bringing his 27-foot boat alongside the whale and estimating the whale to be 4 feet shorter than the boat. He sketched the animal for me showing an apical pair of tusk-like mandibular teeth, two converging throat grooves, and hind margins of the flukes slightly projecting instead of notched at the mid-point. Upon my explaining that these were characters known only in a family of rare whales, he volunteered to take me in his boat to where the whale's remains were lodged on a bar three miles away. This was in spite of the facts that storm warnings were up and a 40-mile gale was blowing. We reached the rotting carcass and towed it to the lee of a small island where park ranger David Bogart, Doolittle, and I were able to remove and partially clean the head.

The tusks were very worn, one smoothly, the other roughly in part as if it had been scored against rock in the death struggle. The right ramus of the mandible had been broken through on a vertical transverse plane 36% of its length from the foreward end. The left ramus had been broken through near the articular end, and a large crack ran forward from the break for almost half the length of the jaw. These serious breaks and crack had fused well with the mandible parts in good position and were surely unrelated to the animal's death. Such fractures may be evidenced of the intra-specific fighting usually attributed to the goose-beaked whale (Fraser, 1949: 276, and Kellogg, 1940: 69). Figures 17, 18, and 19 illustrate this mandible and skull.

(b) The Florida Geological Survey has in its collection a skull of a female or immature of this species which director Herman Gunter permitted the writer to examine. It came from "the Florida Keys, west coast" and was

presented some years ago by a Mr. Sealy. Although the mandible was missing and some bones broken, some measurements of it are presented in table II.

(c) Jack Perry and Walter Casson, Jr., of New Port Richey, Pasco County, unearthed from storage in Gulf High School of that town a skull of a small whale. Seeking to identify it, they sent photographs of it to the United States National Museum. Henry Setzer of that institution identified the photographs as *Ziphius* and put me in touch with Perry and Casson. I was able to examine and measure this fine skull and mandible which were evidently from one adult male individual. The specimen had been presented to Gulf High School by an old naturalist who had obtained it from a small

Fig. 17.—Skull of goose-beaked whale from Conch Key. Ventral aspect, showing key character of four parallel grooves along mid-portion of beak.

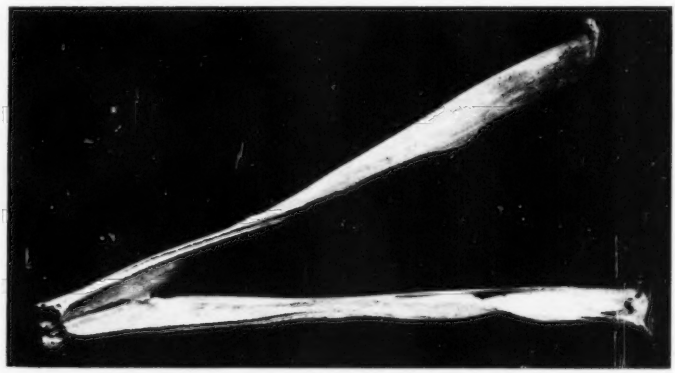

Fig. 18.—Lower jaw of goose-beaked whale from Conch Key. Dorsal aspect. Note apical sockets for two functional teeth.

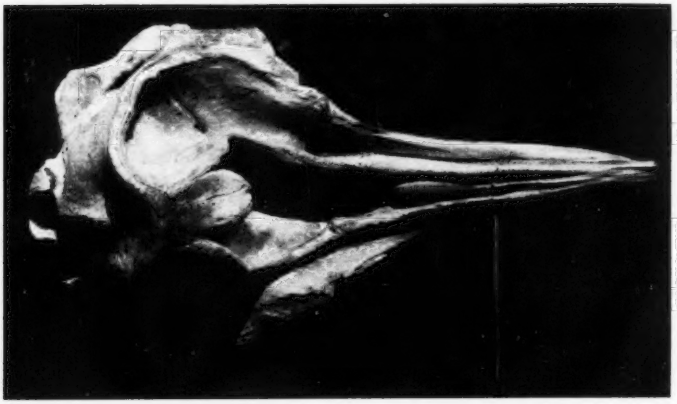

Fig. 19.—Skull of goose-beaked whale from Conch Key. Dorsal aspect.

whale which washed ashore near Hudson, Pasco County (lat. 28°23′), on the Gulf Coast about 1930.

(d) In the South Florida Museum at Bradenton, Manatee County, manager Lester Leigh permitted me to examine and measure the skull and mandible of a female or immature. This specimen is perfect excepting for the proximal ends of the mandible having been sawed off. Three vertebrae found with the skull are displayed with it. Leigh says that it was found imbedded in the beach sand near Venice, Sarasota County, (lat. 27°09′ and long. 82°27′) about 1939.

Measurements are presented in table II for skulls of individuals *a*, *b*, *c*, and *d*, discussed above and *a* is represented now in the collections of the United States National Museum by the teeth and earbones. See Figure 16 for charted distribution of substantiated strandings. Figures 17, 18, and 19 illustrate the skull and mandible of a male.

SIMPLIFIED KEY TO IDENTIFICATION OF FLORIDA MARINE MAMMALS

The author includes this key in non-technical language to assist anyone interested in identifying properly a marine mammal stranded in Florida and to encourage such persons to publish their findings with proof. A good photograph of a pigmy sperm whale, for instance, showing the under-shot jaw or the spacing of one eye and the blowhole on the head, would be excellent proof of one's find. Published even in a newspaper, this might find its way into the meager fund of our permanent knowledge of these animals.

This key includes several species not now known to Florida waters, but whose known distribution suggests the possibility. Species not now known to Florida, and not discussed in the foregoing accounts, are followed in the key by a line of dots instead of a page number. Mammals so rare and poorly known that a university-trained mammalogist might appreciate being called even some distance to study it on the scene, are asterisked.

To include in this key a creature called the "common porpoise" not known to Florida requires explanation. Over most of the northern North Atlantic the common small inshore cetacean is this true, beakless porpoise *Phocaena phocaena*. It has been known as the "common porpoise" for generations. Our ancestors coming from that area to the southeastern coast of the United States, applied this name of "porpoise" to the commonest, small, inshore cetacean they saw here, the bottle-nosed dolphin *Tursiops truncatus*. This animal, however, is properly called a dolphin because it has conical teeth and a beak. Porpoises have spade-shaped teeth and no beak. It is not even proper to call the bottle-nosed dolphin the "common dolphin," because *Delphinus delphis* has been so known from the origins of our western civilization in the Mediterranean, where it was the commonest small cetacean encountered by the ancient Phoenicians and Greeks.

Increasing distributional knowledge of whales in the beaked whale family invites the use of common names more meaningful to general students, and geographic common names are offered here for the beaked whales *Mesoplodon europaeus* and *Mesoplodon bidens*.

The following key has been adapted from other keys by Fraser (1949: 344), Ulmer (1941a: 120), and J. A. Allen (1880: 462). Dr. Kellogg read the key, made some corrections, and contributed the lengths given for most of the animals.

X. Hind flippers (modified hind legs) present. No mentionable tail. (Pinnipeds)
  Y. Small front teeth 6 above and 4 below ..... *Phoca vitulina* (Linnaeus) HARBOR SEAL
  YY. Small front teeth 4 above and 4 below ..... *Monachus tropicalis* (Gray), WEST INDIAN SEAL* (p. 118)
  YYY. Small front teeth 4 above and 2 below ..... *Cystophora cristata* Erxleben, HOODED SEAL (p. 120)

XX. No hind limbs present. Tail well-developed.
  Z. Tail wide but rounded, shaped like a canoe paddle ..... *Trichechus manatus latirostris* Harlan, MANATEE or SEA COW (p. 120)
  ZZ. Tail expanded laterally to form two flukes and ending in a squared off trailing edge. (Cetaceans)
    A. Whalebone present. Twin blow-holes ..... (whalebone whales)
      B. Upper border of lower lip much arched on sides. Outer surface of throat smooth. No dorsal fin. Whalebone 6 to 9 feet long. Entire length up to 60 feet ..... *Eubalaena glacialis* (Borowski), NORTH ATLANTIC RIGHT WHALE (p. 122)
      BB. Lower lip not greatly arched. Outer surface of throat longitudinally grooved. Dorsal fin present. Whalebone less than 4 feet long.
        C. Flipper length 1/3 of total length of body. Lower margin of flippers and hind margin of flukes scalloped. Width between throat grooves 5 to 8 inches. Series of prominent knobs on head and jaws. Entire length up to 50 feet ..... *Megaptera novaeangliae* (Borowski) HUMPBACK WHALE (p. 127)
        CC. Flipper length no more than 1/6 of entire length; flipper not scalloped on lower margin. Width between throat grooves 2 to 3 inches. No series of knobs on head and jaws. (finback whales)
          D. Whalebone plates yellowish-white or slate-colored or both.
            E. Flipper with white patch conspicuous on outer (upper) surface.

Entire length up to 33 feet. Whalebone plates and fringes all white or yellowish, longest plate about a foot long ....*Balaenoptera acutorostrata* Lacépède, PIKED WHALE (p. 125)

EE. Entire length 42 to 80 feet. Flipper not white patched on outer surface.

F. Entire length up to 49 feet. Whalebone white for foremost 2 feet (often with gray stripes), remainder grayish black ..... *Balaenoptera brydei* Olsen, BRYDE'S WHALE*

FF. Entire length 70 to 80, usually about 70, feet. Whalebone yellow and slate colored except on front, right side of jaw, where it is white. Longest plate not more than 3 feet long. Underside of flippers and flukes white .....*Balaenoptera physalus* (Linnaeus), FINBACK WHALE (p. 123)

DD. Whalebone plates black.

G. Entire length up to 100 feet, usually about 85 feet. No large white area on surface of throat. Throat grooves extending at least to navel. Whalebone fringes coarse and black, longest plate not more than three feet long ....*Sibbaldus musculus* (Linnaeus), BLUE WHALE

GG. Entire length up to 60 feet. White area on throat. Whalebone fringes fine, soft, and white. Throat grooves not reaching navel ....*Balaenoptera borealis* Lesson, SEI WHALE (p. 124)

AA. Teeth present although sometimes concealed in gums. No whalebone. Single blowhole.

H. Upper part of head extending appreciably forward of tip of lower jaw.

I. Body length 28 to 60 feet. Head massive and 1/3 of body length. Blowhole located far forward of the eyes ....*Physeter catodon* Linnaeus, SPERM WHALE (p. 127)

II. Entire length 9 to 13 feet. Head only 1/6 of entire length. Teeth 9 to 14 pairs, confined to lower jaw, slender and curved. Dorsal fin well-developed. Flippers tapering ....*Kogia breviceps* (Blainville), PIGMY SPERM WHALE (p. 128)

HH. Most forward part of head not extending appreciably beyond tip of lower jaw.

J. Two conspicuous grooves on outer surface of throat forming a "V" shape pointed forward. Dorsal fin present, and considerably behind middle of animal's entire length. No notch in middle of trailing edge of flukes .....(beaked whale family)

K. A pair of teeth at tip of lower jaw (sometimes hidden in the gum).

L. United part of lower jaws less than 1/4 of length of lower jaw. Four parallel grooves in middle portion of lower surface of beak. Entire length up to 26 feet .....*Ziphius cavirostris* (G. Cuvier), GOOSE-BEAKED WHALE* (p. 148)

LL. United portion of lower jaw more than 1/4 of lower jaw length. Only two parallel grooves in middle portion of lower surface of beak. Entire length up to 17 feet .... *Mesoplodon mirus* True, TRUE'S BEAKED WHALE*

KK. No teeth at tip end of lower jaw.

M. A single pair of teeth in united portion of lower jaw, but not at tip end. Animal's entire length up to 20 feet .....*Mesoplodon europaeus* Gervais, GULF-STREAM BEAKED WHALE* (p. 147)

MM. A single pair of teeth back of united portion of lower jaw.

N. Teeth not exceptionally large and located immediately back of united portion of lower jaw. Highest part of jawbone at rear end of jaw. Entire length about 15 feet .... *Mesoplodon bidens* Sowerby, EASTERN ATLANTIC BEAKED WHALE

NN. Teeth exceptionally large and located approximately midway in the length of the lower jaw. Bone about the base of

the tooth rises higher than any other part of jawbone. Animal's entire length up to 15 feet ..... *Mesoplodon densirostris* Blainville, BLAINVILLE'S BEAKED WHALE*

JJ. No converging grooves on throat. Dorsal fin about midway in entire length of animal. Notch in middle of trailing edge of flukes.

O. Head without a distinct beak.

P. Body length no more than six feet. Teeth spade-shaped and 22-27 on each side of upper and lower jaws ..... *Phocoena phocoena* (Linnaeus), COMMON PORPOISE

PP. Body length 7½ to 30 feet. Teeth conical.

Q. Head long and conical. Crowns of teeth naturally roughened or corrugated. Animal's entire length about eight feet ..... *Steno bredanensis* (Lesson) ROUGH-TOOTHED DOLPHIN* (p. 132)

QQ. Head blunt. Crowns of teeth smooth.

R. Teeth absent in upper jaw, 2 to 6 on each side in lower jaw. Color gray, deepening to black on fins and tail. Entire length up to 13 feet ..... *Gramphidelphis griseus* (Cuvier), RISSO'S DOLPHIN*

RR. Teeth in both jaws.

S. Flipper length at least 1/6 of entire length. Head bulged forward especially in males. Teeth up to ½ inch in diameter ..... *Globicephala macrorhyncha* (Gray), PILOT WHALE OR BLACKFISH (p. 141)

SS. Flipper length less than 1/6 of entire length. Head not bulging conspicuously forward. Teeth exceeding ½ inch in diameter.

T. Flippers rounded in outline. Body color conspicuous black and white, with a white spot just behind eye. Teeth 1 inch or more in diameter. Entire length in males up to 30 feet, in females up to 15 ..... *Grampus orca* (Linnaeus), KILLER WHALE (p. 138)

TT. Flippers tapering to a point. Color entirely black. Teeth ½ to ¾ inch in diameter. Animal's entire length up to 18½ feet ..... *Pseudorca crassidens* (Owen), FALSE KILLER (p. 140)

OO. Head with the beak marked off distinctly from the forehead by a deep crease or angle.

U. Beak short, 2 or 3 inches long. Teeth only 20 to 25 to a side on either jaw and ⅜ inch in diameter. Animal's entire length up to 12 feet ..... *Tursiops truncatus* (Montague), BOTTLE-NOSED DOLPHIN (p. 134)

UU. Beak longer, up to six inches. Teeth much more numerous and much smaller.

V. Between black of back and white of belly, an area of undulating lines of gray, yellow, and white appear to overlap in area behind flipper. Teeth 40 to 50 to a side on either jaw. Entire length up to 8 feet ..... *Delphinus delphis* Linnaeus, COMMON DOLPHIN (p. 133)

VV. No such over-lapping bands of color evident. In here fit a number of rare and little known dolphins of the genera *Stenella** and *Sotalia.** If your dolphin fits here, by all means photograph it in the flesh, and knifing the skull away from the backbone, remove the head, pack it with 5 or 10 pounds of dry ice, mark where the animal was found and when, and express it to the United States National Museum labeled *perishable*.

SUMMARY

Reports of the occurrence of two species of seals, one manatee, twelve whales, and six dolphins in Florida waters are set forth. These are *Monachus tropicalis, Cystophora cristata, Trichechus manatus latirostris, Eubalaena glacialis, Balaenoptera physalus, Balaenoptera borealis, Balaenoptera acutorostrata, Megaptera novaeangliae, Physeter catodon, Kogia breviceps, Stenella plagiodon, Stenella frontalis, Stenella longirostris, Steno bredanensis, Delphinus delphis, Tursiops truncatus, Grampus orca, Pseudorca crassidens, Globicephala macrorhyncha, Mesoplodon europaeus,* and *Ziphius cavirostris.* Extension of previously known range is indicated for *B. acutorostrata, S. longirostris, Grampus orca,* and *Ziphius cavirostris.* Records extending the known breeding season and of a tendency to assemble during a cold period are reported for *Trichechus.* Evidence of migratory movement are reported for *Globicephala, Delphinus* and *S. plagiodon,* and restriction to deep, clear water for *S. plagiodon* and *Delphinus. Tursiops truncatus* is shown to be present in the Everglades National Park throughout the year. An instance of a free, wild *Tursiops* supporting its dead young at the surface is described and a breeding record provided which extends its season for births to about November first. A measurement of the speed of *Tursiops* is 12.2 m.p.h. or 10.7 knots. Body measurements are provided for *B. physatus, B. acutorostrata,* and *Tursiops.* Tables of skull measurements are provided from 2 *B. acutorostrata,* 2 *Tursiops,* 1 *Grampus,* 1 *Pseudorca,* 5 *Globicephala,* and 4 *Ziphius.* A key in simple terms is provided for the identification of marine mammals which do or might occur in Florida waters.

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A New Species of Lundbladia and Remarks on the Family Hydryphantidae (Water Mites)

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There are a number of interesting water mites in various parts of the world that live in spring seepage areas and similar niches. None of these mites has been recorded from North America. Thus, the discovery of a new species in a seepage area near Kankakee, Illinois, is a matter of interest. The mite belongs to the genus *Lundbladia* (Hydryphantidae), a group that to date has been known from Europe and Java. This paper is mainly concerned with the diagnosis of this genus and the description of the new species.

Most of this work has been done at Kansas State College, and I wish to express my appreciation for the encouragement and guidance given me by members of the departments of Entomology and Zoology. For an introduction to this study and constant help and inspiration I am indebted to the members of the Division of Insects of the Chicago Natural History Museum.

Because the literature on North American water mites contains essentially no diagnoses of the higher categories of the Hydryphantidae I have taken this opportunity to summarize the diagnostic characters that serve to separate the hydryphantid genera (in North America) from each other. It must be remembered that there are doubtless other genera and species yet to be found in this country which will necessitate revision of these summaries. Viets (1936a) gives keys to the genera of water mites of the world that will be useful in identifying genera not included in this paper.

A great many technical terms have been found necessary for the description of hydryphantids. These are defined in the glossary at the end of this paper and in most cases the structures are illustrated and labeled on plate III.

Hydryphantidae*

Large, soft-bodied, red mites; lateral eyes separate; often bearing a large frontal shield with or without other dorsal sclerites. Coxae in four groups of two each. With at least three pairs of large, circular, genital acetabula. At least the center pair, but never all of the genital acetabula situated between the two genital sclerites.

Hydryphantinae

Hydryphantids with the posterior margin of the frontal shield deeply emarginate; lacking a well developed series of sclerites and glandularia; setae of the legs fine, elongate, fitted for swimming.

* The family Hydryphantidae as defined by Lundblad (1941) contains both the Thysidae and Hydryphantidae (*sensu* Viets 1936a). Lundblad's classification (1941) is followed in this paper.

This diagnosis will serve to separate the only genus known from North America, *Hydryphantes*. Marshall (1946) treats all the North American species but one and her paper is a useful center of reference. *Hydryphantes*

are large (1-3 mm.), actively swimming red mites frequently found in shallow water and common in vernal ponds.

THYASINAE

Hydryphantids with a well developed pattern of sclerites and glandularia; frontal shield, if present, never deeply emarginate posteriorly; leg setae coarse, not fitted for swimming.

Of the twenty genera assigned to the subfamily Thyasinae only three have been recorded from North America as compared with twelve from Europe. Recent field work shows that the difference is doubtless the result of inadequate collecting in this country. Lundblad (1933) has studied the morphology and phylogeny of the Thyasinae. Several keys to the genera of the world are available (Viets 1936a, Lundblad 1933, 1945).

The Thyasinae average slightly more than a millimeter in length. They are poor swimmers and are found on the bottom of shallow waters or in mats of vegetation.

Genus THYAS

With three pairs of genital acetabula; unpigmented median eye not enclosed in a sclerotized frontal shield; dorsum with many small sclerites.

In Europe the species of *Thyas* occur in a variety of situations. Some species are restricted and others are quite general as regards habitat associations. They are found in temporary waters, swamps, springs, and brooks.

Thyas stolli Koenike (1895) was described from moss in a marsh near "North Fock, (*sic.* probably meant to be forks) Old Man River, in Rocky Mountains, Canada; 10. Aug. 1883.". Marshall (*in litt.*) considers this locality to be in Alberta. McClure (1943) records the species from Manitoba.

The only other records of the genus in North America are Kenk's record (1949) of *Thyas* sp. from a temporary pond in southern Michigan, and the record of an undetermined species of *Thyas* from New Brunswick by Habeeb (1950).

Genus PANISUS

With three pairs of genital acetabula; median eye unpigmented, enclosed in a large frontal shield that bears a pair of fine setae; dorsocentralia 3 and 5 fused together mesally, dorsocentralia 2 and 4 separate.

Panisus cataphracta (Koenike) was described as a *Thyas* but subsequently was assigned to *Panisus* by Koenike (1912). The type locality is "Small brook between the North and Middle Focks (*sic.* probably meant to be forks) of Old Man River; 15. Aug. 1883.". Marshall (*in litt.*) considers this locality to be in Alberta. No other records are known. In Europe the species of *Panisus* are found in springs and spring-fed brooks.

Genus PANISOIDES or PANISOPSIS

According to Lundblad (1941) the generic assignment of *Thyas pedunculata* Koenike (1895) cannot be made on the basis of the description. The only known locality is the type locality "Kit-a-mun River; 23. Juli 1883", which is probably in British Columbia (Marshall *in litt.*). Both *Panisoides* and *Panisopsis* are found in cold waters in Europe. The genera hold in

common these characteristics. Three pairs of genital acetabula. Median eye in a large frontal shield that bears a pair of setae and is followed by four pairs of dorsocentralia; the latter may or may not be fused mesally. All other sclerites separate.

Panisopsis is distinguished by the pigmented median eye and a tendency for each pair of dorsocentralia 2-5 to be fused mesally. In *Panisoides* the median eye is unpigmented and dorsocentralia 2-5 are separate.

Genus LUNDBLADIA

With three pairs of genital acetabula; median eye unpigmented, enclosed in a frontal shield; dorsocentralia 3 and 4 each mesally fused, dorsocentralia 5 separate; third segment of the anterior leg normal; genital sclerite elongate, posterior genital acetabula posterior to, and fused with the genital sclerite.

The lateral eye is fused mesally with the preocularia. The large frontal shield is formed by the fusion of four pairs of sclerites; the prefrontalia, the postfrontalia, and the dorsoglandularia 1 and 2. The two setae of the frontal shield are the postocularial setae. Dorsocentralia 3 and 4 each fused together mesally, dorsocentralia 5 are large but separate. Center pair of glandularia on the posterior margin are the dorsoglandularia 7. Dorsoglandularia 1 are in the center of the frontal margin. Dorsoglandularia 2 through 6 are located in a row between the dorsocentralia and the dorsolateralia. Lateroglandularia 1 through 3 are visible dorsally near the sides but lateroglandularia 4 is usually ventrally placed.

The coxae occupy much of the anterior half of the ventral surface. Coxae I and II are fused together to form coxal group 1. Coxae III and IV are fused together to form coxal group 2. There is a dorsolateral development of the second coxal group that is associated with the leg bases. Coxoglandularia 1 is large, located laterally to the first coxal group. Coxoglandularia 2 is adjacent to the meso-posterior corner of coxal group 2. Ventroglandularia arranged in a triangular pattern, the most anterior pair is ventroglandularia 1, the mesal pair is 2, and the lateral pair is 3.

Just behind the first coxal group is the genital field. Two sinuate, elongate, genital sclerites enclose a papillated area around the slit-like genital opening. Anteriorly the genital area is bounded by a transverse, usually triangular, sclerite. Anterior two pairs of acetabula are situated between the genital sclerites, the posterior acetabula lie behind and fused with the genital sclerites. Males with a small, easily overlooked, sclerotized internal structure, the penis, usually located very near the genital opening between acetabula 1 and 2.

Legs short with extremely heavy segments bearing many heavy setae. Legs of the male generally stouter in structure and chaetotaxy than those of the female.

The species assigned to the genus *Lundbladia* are very closely related and separated by differences in chaetotaxy and some small structural differences. Three species, *L. petrophila* (Michael 1895), *L. rutae* (Lundblad 1942), and *L. plumifera* (Angelier 1949) are Palearctic. The remaining described species *L. feuerborni* (Viets 1929b) was described from moss in two Java springs.

The extremely heavy, short segmented legs with heavy outwardly directed setae are adaptations for crawling in mats of vegetation. Water mites adapted for crawling usually have the muscles of the basal leg segments strongly developed and the apodemes of the coxae very large. Such is the case in *Lundbladia,* that have become so modified that they cannot swim or resist currents of water. The species of *Lundbladia* are all associated with cold waters and all the records are from moss in situations where a stream, spring, or waterfall wets a rock surface.

Lundbladia muscicola sp. nov.

Distinguished from all other species of *Lundbladia* by the expanded dorsal plates of the male. The row of setae on the mesal margin of coxa II in *L. petrophila, rutae,* and *feuerborni* is absent in *L. muscicola* and *plumifera. L. muscicola* has four setae on the anterior margin of coxae III whereas *L. plumifera* has but two.

Male: Dorsum (fig. 1). Plates so expanded that indentations are necessary to provide room for the dorsoglandularia.

Coxae I (fig. 2). Bearing a row of about 26 closely placed pinnate setae on the mesal margin, and a long, posteriorly-directed, simple seta near the posterior end of the row of setae; a pinnate seta at the anterolateral angle of coxa; a posteriorly-directed pinnate seta in the center of the anterior half. Space between the coxae narrowed posteriorly.

Coxa II (fig. 2). One pinnate seta at the anteromesal angle; two pinnate setae on or near the lateral margin.

Coxa III (fig. 2). Two pairs of setae on the anterior margin, one mesal and one lateral; one pinnate seta on the posterolateral margin.

Coxa IV (fig. 2). With three setae; one long pinnate seta near the anterolateral angle, one just anterior to the middle of the coxal plate, and a short, stout pinnate seta on the posterior angle.

Genital Field (fig. 2). Genital sclerites narrow, sinuous. A group of three inwardly-directed setae on the mesal margin of each genital sclerite; behind this group a second group of four inwardly-directed setae; one seta on the postero-lateral angle. Two anterior pairs of genital acetabula lie in a papillated area which surrounds the small, slit-like genital opening. Acetabula 3 very large, elliptical, attached to the posterior end of the genital sclerite. A small triangular sclerite bounds the anterior of the genital field.

Mouthparts (figs. 7, 15). Base of the capitulum rounded and not so broad as in the female; palp and stylet same as the female (figs. 13, 14).

Legs (fig. 6). Segments 1-4 of legs I-III shorter and stouter than in the female, setae of these legs tending to be stouter in the male.

Female: Dorsum (fig. 3). Plates small, membranous areas large, adequate for the glandularia without indentations of the dorsal plates except for dorsoglandularia 6.

Coxa (fig. 4). Smaller than those of male; mesal margins of coxal groups 1 parallel; coxal group 2 with mesal margin rounded. About 18 pinnate setae on the mesal margin of coxa I; remainder of coxal setae as in male.

Genital Field (fig. 4). Genital sclerite slightly wider than that of the male, but not covering the genital acetabula. Three setae on the genital

sclerite; one on the antero-mesal angle, two on the posterior of the lateral margin. A small impunctate sclerite that bears two setae projects postero-mesally from the genital sclerites. Posterior acetabula the largest, and closely associated with the posterior of the genital sclerite. Genital field bounded anteriorly by a large, transverse, sclerite.

Mouthparts (figs. 8, 13, 14). Base of the capitulum broad and truncate in comparison with that of the male.

Legs (fig. 5). Segments 1-4 of legs I-III somewhat thinner and elongate as compared with those of the male.

Nymph: The nymph is easily recognized as a *Lundbladia.* All the sclerites of the adult are present, although they are widely separated and smaller than in the adult.

Genital Field (fig. 12). Two pairs of genital acetabula are present, each with a simple, anteriorly-directed seta. A small median pore is present between the acetabula. Immediately lateral to the acetabula is a small sclerite bearing two seta.

Larva: In general the illustrations are thought to be adequate to indicate the form and chaetotaxy of the body.

Dorsum (fig. 11). Eight pairs of setae in longitudinal rows on either side of the mid-dorsal line; third and fourth pairs on a lightly sclerotized plate that bears the median eye in the center. A lateral eye situated on each side of this plate. Four pairs of setae forming a row on each side of the center rows of setae.

Venter (fig. 10). Coxae I and II close together, with a small circular sclerite between them, coxae I and III each with a seta on the inner angle. Four pairs of setae on the venter posterior to the coxae.

Mouthparts (figs. 9, 10). Capitulum shorter, broader, thicker, than that of the adult. Stylets of larva heavier and shorter than those of adult. Palp 5 segmented and completely different in proportions and structure from those of the adult (fig. 9).

TABLE I.—Measurements of *Lundbladia muscicola* n. sp.

	Male (15)	Female (29)	Nymph (5)	Larvae (24)
Body Length	.97-.78	1.06-1.47	.57-.77	.21-.25
	(.90)	(1.22)	(.69)	(.23)
Body Width	.46-.63	.67 - .92	.35-.50	.18-.22
	(.55)	(.80)	(.43)	(.21)
Frontal Shield	.35-.41	.34 - .45	.20-.25	.....
Length	(.39)	(.39)	(.23)	.....
Frontal Shield	.32-.41	.35 - .48	.18-.27	.....
Width	(.36)	(.39)	(.23)	.....
Capitulum	.29-.35	.27 - .36	.18-.21	.....
Length	(.34)	(.34)	(.20)	.....

Measurements. The measurements were made from slide mounts of dissected individuals and the overall dimensions could not be taken. The measurements of the females are variable due to the distention of gravid specimens. Body length is measured from the anterior of the frontal shield to the poste-

rior margin of the dorsocentralia 5, the body width is the distance between the lateral margins of dorsolateralia 3. The entire body of the larva is measured, however the measurements are from slide preparations that are subject to some distortion. The number of specimens measured is recorded in parentheses by the headings. The range is recorded with the mean listed underneath in parentheses. The measurements are given in fractions of millimeters.

Holotype: An adult male from Rock Creek Canyon, 10 miles northeast of Kankakee, Kankakee Co., Illinois, July 29, 1950, R. Mitchell, and H. Dybas leg.

Paratypes: 4 adult males, same data as holotype. 10 adult males, same locality as holotype, August 5, 1950, R. Mitchell leg. 23 adult females, same data as holotype. 35 adult females, same locality as holotype, August 5, 1950, R. Mitchell leg. 1 nymph, same data as holotype. 5 nymphs, same locality as holotype, August 5, 1950, R. Mitchell leg. 10 slides of larvae, same locality as holotype, August 5, 1950, R. Mitchell leg.

The types will be distributed as follows: Holotype and a paratype female, nymph, and larva to be deposited at the Chicago Natural History Museum. A set of paratypes consisting of a male, female, and larva will be deposited at each of the following institutions: Illinois State Natural History Survey, Urbana, Illinois and the United States National Museum, Washington, D. C.

Remarks.—The dorsal plates are variable in shape in the adult and in several specimens there is an irregular fusion of some plates.

One anomalous specimen was found that has a penis but otherwise is female in structure. The genital field is typically female; the form of the coxal group, though somewhat expanded, is still essentially like that of the female; leg I is female-like; the configuration of the dorsum is typically female; the measurements of this individual are very colse to the mean of the female measurements. A similar anomalous specimen of *Piona coccinea* (C. L. Koch) has been described by Viets (1929a).

Association of the nymph and larva were made through collecting. The larva of *L. muscicola* is very close to the larva associated with *L. rutae* (Lundblad 1942).

LIFE HISTORY

The following observations and collections were made on July 29, 1950, and August 5, 1950, at Rock Creek Canyon, 10 miles north of Kankakee, Illinois, and on a culture maintained for two weeks following the last collection.

Where Rock Creek enters the Kankakee River from the north it cuts a deep, steep-sided canyon and the stream occupies most of the canyon floor. At several spots along the limestone walls of the canyon are small areas of seepage where a trickle of water runs down the rock face. A mat of vegetation may develop at these areas of seepage, usually predominantly moss but often with some filamentous algae present, or else a sludge-like deposit of inorganic and organic material may accumulate. The water temperature in these seeps was around 18° C. as compared to the water temperature of 24° C. recorded in Rock Creek. In this seepage habitat species of three very interesting genera of water mites were abundant, *Hydrovolzia*, *Tyrrellia*, and *Lundbladia*.

Lundbladia muscicola was particularly abundant in the mats of vegetation. This red mite is slow in its movements. Masses of less than 15 red eggs

enclosed in a thick gelatinous matrix are secured to strands of vegetation. Immediately after hatching the larvae crawl up to the surface of the water where they are found on the surface film. Their movements are fairly slow. Frequently the larvae are found in masses of about 5 mm. in diameter, possibly numbering 100 to 200 individuals. Each of these masses was situated directly over a tipulid pupa. Parasitized adult tipulids were found resting in the area of seepage. The mites were attached by their stylets to membranous areas of the body.

The parasitized tipulid adult and the pupae have been identified as *Limonia* (*Dicranomyia*) *humidicola* (O. S.) by Dr. J. Speed Rogers, who states that the species has a wide range in eastern North America and can be found along most brooks, streams, or rills that have overhanging clay or rocky banks with areas of seepage.

GLOSSARY OF TERMS

Lundblad (1927) proposed a system of names for the sclerites that has received general acceptance and his system is followed in this paper. There are numerous non-setigerous sclerites that are constant in number and position in most of the thyasids. Each serves as a muscle-attachment; the area of muscle attachment is distinguished by dense, fine porosities, which indicate the component parts of large fused plates. The sclerites are named by combining a prefix that indicates position with the root -alia (e. g., dorsolateralia). Equally constant are the small, setigerous plates which bear a pore that is presumed to be glandular. To name these, a prefix that indicates position is combined with the root glandularia (e. g., lateroglandularia). Where structures lie in a longitudinal series they are numbered from anterior to posterior.

The coxae, the legs, and their segments are referred to by a numerical system. Roman numerals refer to the leg pairs and coxae beginning anteriorly. Arabic numbers from 1 to 6 refer to the leg segments beginning with the first segment distad of the coxa.

Anal plate—A small elliptical plate on the mid-ventral line that bears the anal opening (fig. 4).

Camerostome—The depression between coxae I that receives the capitulum.

Capitulum—A trough-like sclerotized structure that bears the mouth and the feeding organs (figs. 7, 8, 15).

Coxae—The large plates of the ventral surface that bear legs. The coxae are called "epimera" by most workers on the water mites (fig. 4).

Coxal group—The sclerite that results from the fusion of two or more coxae (fig. 4).

Coxoglandularia—Glandularia (2 pairs) each one of which is situated posterior to a coxal group (fig. 4).

Dorsocentralia—Five pairs of sclerites that form a row along each side of the mid-dorsal line. These are often fused together mesally (fig. 3).

Dorsoglandularia—Setigerous glandular plates in a row of seven along each side of the dorsum lateral to the dorsocentralia (fig. 3).

Dorsolateralia—Four pairs of simple sclerites that form a row between the dorsocentralia and the lateral margin (fig. 3).

Frontal shield—A large shield formed through the fusion of various dorsal sclerites (fig. 3).

Genital acetabula—Circular sclerotized structures associated with the genital field (fig. 4, labeled "Acetabula 1, 2" and "Acetabula 3").

Genital field—The general area occupied by the genital sclerites, acetabula, and the genital opening.

Genital sclerite—The elongate sclerites usually forming the lateral margin of the genital field (fig. 4).

Glandularia—A general term referring to any of the small, setigerous sclerites that bear a pore-like opening presumed to be glandular.

Lateral eye—A capsule-like projection from the corner of the frontal margin; it bears two crystalline lenses (fig. 3).

Lateroglandularia—Four pairs of glandularia that are located along the lateral margin of the body (fig. 3).

Median eye—A small eye located on the mid-dorsal line between the lateral eyes (fig. 3).

Palps—A pair of five-segmented grasping structures that are inserted on the sides of the capitulum (figs. 9, 13).

Penis—A complex, sclerotized, internal structure of the male, presumably copulatory in function.

Post-genital plate—A simple circular sclerite on the mid-ventral line between the genital field and the anal plate (fig. 4).

Postfrontalia—A pair of small, simple sclerites behind the median eye.

Postocularia—A pair of small, setigerous sclerites behind the median eye.

Prefrontalia—A pair of small, simple sclerites just in front of the median eye.

Preocularia—A pair of small, setigerous sclerites on the front of the body.

Stylets—Paired two-segmented, elongate, piercing organs that fit loosely on the top of the capitulum (fig. 14).

Ventralia—Two pairs of large sclerites on the ventral surface of the body (fig. 4).

Ventroglandularia—3 pairs of glandularia situated on the ventral surface posterior to coxae IV (fig. 4).

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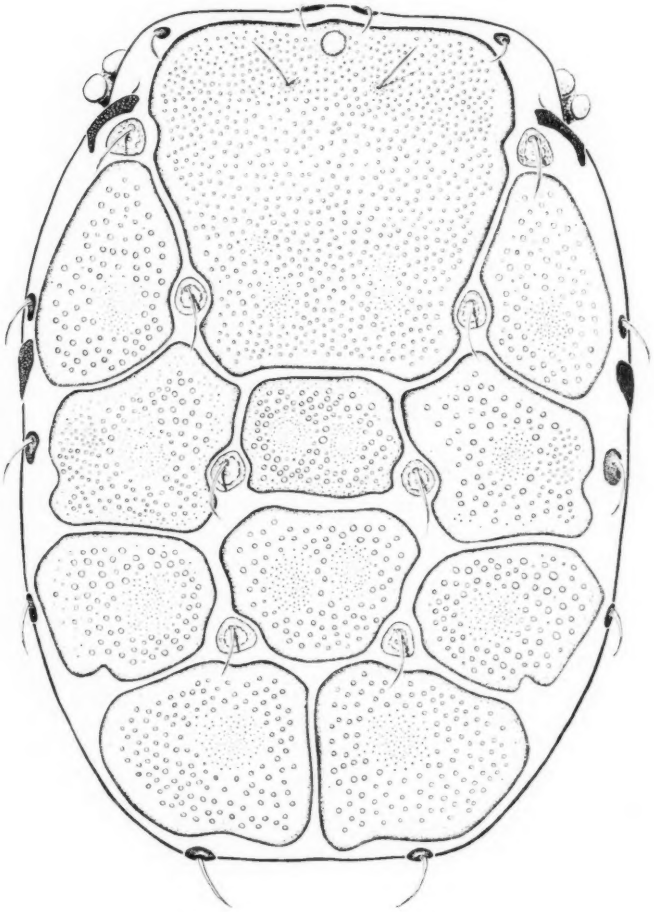


Fig. 1.—*L. muscicola*, male, dorsum

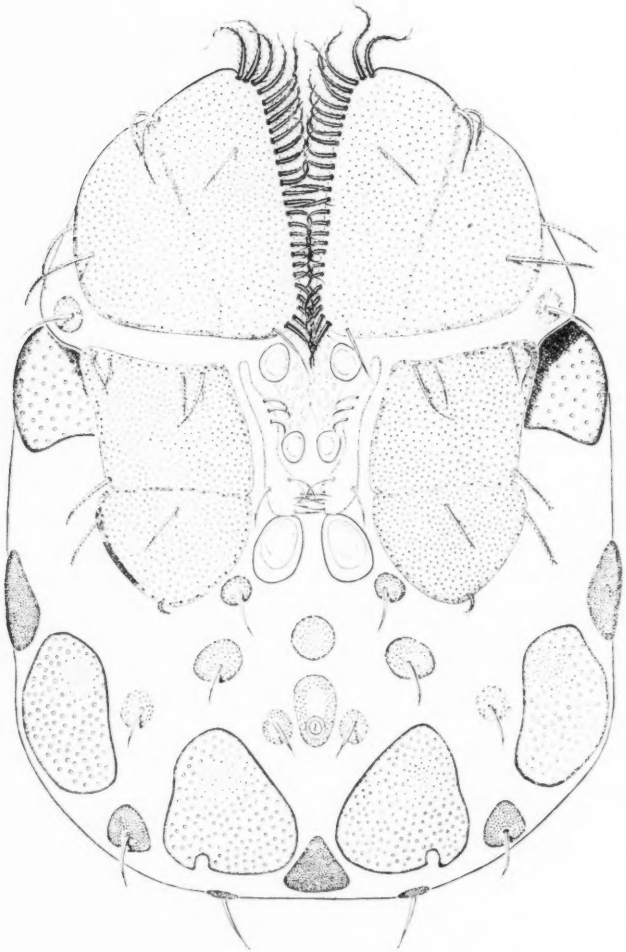
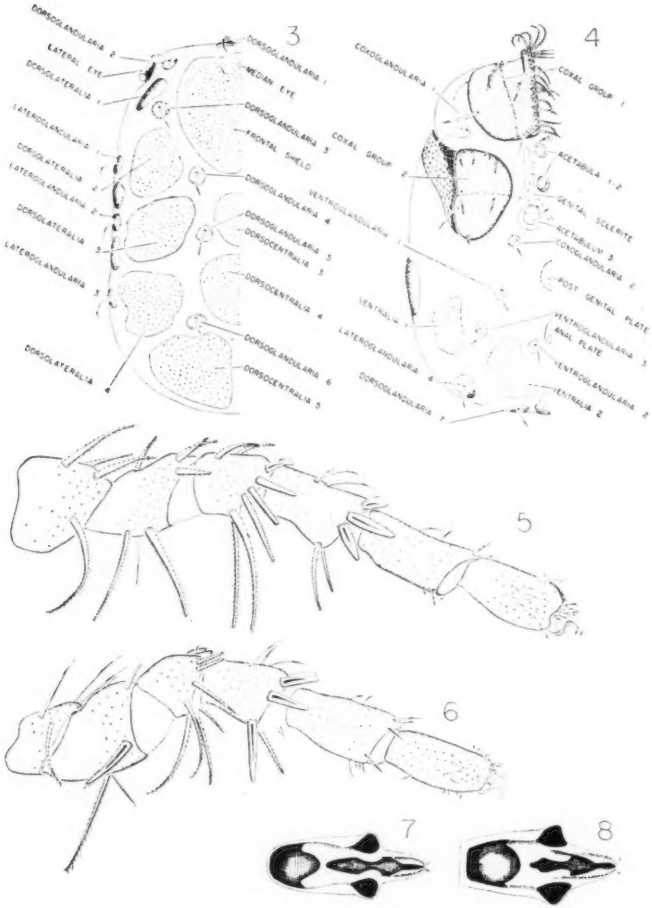
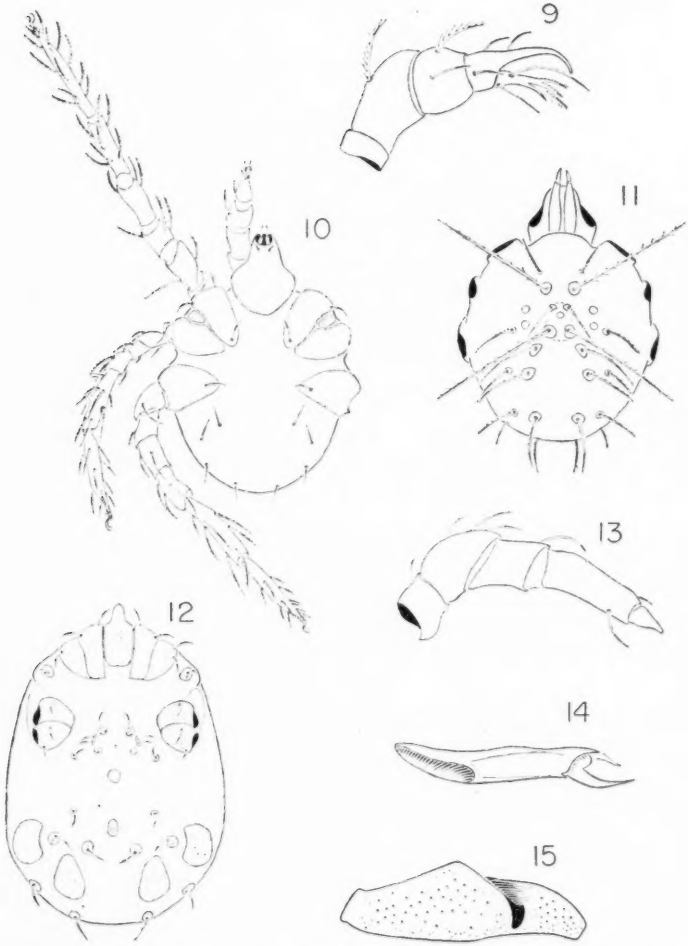


Fig. 2.—*L. muscicola,* male, venter



Figs. 3-8. *L. muscicola*.—3. female, dorsum; 4. female, venter; 5. female, anterior aspect, leg I; 6. male, anterior aspect, leg I; 7. male, dorsal aspect, capitulum; 8. female, dorsal aspect, capitulum.



Figs. 9-15. *L. muscicola.*—9. larva, lateral aspect, right palp; 10. larva, ventral aspect; 11. larva, dorsum; 12. nymph, venter; 13. female, lateral aspect, left palp; 14. female, mesal aspect, left stylet; 15. male, lateral aspect, capitulum.

The Ostracode Genus Trachyleberis and its Ally Actinocythereis

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Sylvester-Bradley (1948, p. 294), in his efforts to redefine the genus *Trachyleberis* Brady has referred to it most Tertiary and later ornate forms formerly included in *Cythereis* Jones, which Triebel (1940) has shown to be a Cretaceous genus. The genus *Trachyleberis* Brady is here limited to those species with a spiny surface on which the spines are not arranged in a definite pattern. This genus occurs in the American Tertiary with ten species which are here described and figured. American Cenozoic deposits also contain a closely related genus in which the spines are arranged in longitudinal rows, here described as *Actinocythereis*, n. gen. Eight species belonging to this new genus are described and figured. Stratigraphic range of the species belonging to these genera is shown in the accompanying tables.

ACKNOWLEDGEMENTS

Gratitude is expressed to Henry V. Howe, Director of the School of Geology of the Louisiana State University, for the specimens that formed the basis of this study and for access to his type collection and library. Appreciation is expressed for the assistance given by Celia Helena Fajardo in the assembling and final checking of the manuscript.

Types.—All types are catalogued in the Henry V. Howe collection, School of Geology, Louisiana State University, Baton Rouge, Louisiana.

HISTORY OF THE GENUS

Cythere scabrocuneata was described by Brady in 1880 in the "Challenger" report. The species came from three different localities: East Moncoeur Island, Bass's Strait; Inland Sea, Japan; and Wellington Harbour, New Zealand. Brady's figures (plate 17, figures 5a-f and plate 23, figures 2a-c) show at least two species. Unfortunately Brady does not indicate the localities from which his figured specimens came. Under the name *C. scabrocuneata* Brady and Norman (1889, p. 154, pl. 15, figs. 28, 29) illustrate still another species, as noted by Sylvester-Bradley (1948, p. 795). In 1898 Brady (p. 444) described the genus *Trachyleberis*, supposedly with *Cythere scabrocuneata* Brady 1880 as its genotype. Unfortunately, he figured still a fourth species—this one from Lyttleton Harbour, New Zealand—and based his description clearly upon this fourth species rather than on his 1880 material. Of his original figures, only plate 17, figures 5e, f, show organisms closely related to the specimens figured in 1898, since both show ornamentation which consist of irregularly-arranged nodes or spines. In the generic description of *Trachyleberis*, which is far from complete, Brady (1898, p. 444) notes that the observed shell is "beset with prominent nodules and spines. . . ." More detail appears in the description of the genotype, *T. scabrocuneata* (Brady 1898, pp. 444, 445):

Shell of the male seen from the side, elongated, subquadrate, greatest height near the front, and equal to rather half the length; anterior extremity forming a steep curve above the middle, below the middle well rounded and broken up into series of short blunt teeth; posterior extremity irregularly emarginate, narrowed and wedgeshaped, most prominent below the middle; dorsal margin slightly sloping from before backward, and broken into an irregular jagged line; ventral almost straight, with an upward bend behind. Seen from above, the outline is compressed and ovate, more than twice as long as broad, the whole circumference excessively jagged and uneven, tapered at the extremities, which are obtuse, deeply emarginate in front; surface covered with large irregularly-rounded nodules and beset with coarse, rigid hair. A large polished tubercle over the anterior hinge; hingement of two terminal teeth on the right corresponding with the depression on the left. Length 1.1 mm. . . .

Trachyleberis has been ignored by most later workers, and apparently was dropped by Brady himself. Some authors, such as Muller (1912, p. 336) made it a synonym of *Cythereis*. *Trachyleberis* was revived by Sylvester-Bradley (1948), however, as the type genus of his family *Trachyleberidae*. In doing so he (1948, p. 794) emended the genus *Trachyleberis* so as to include most of the Tertiary and later ornate species previously assigned to *Cythereis*. He limited the genus *Trachyleberis* to "*Trachyleberinae* in which anterior and posterior hinge elements are non-denticulate, strongly projecting teeth in the right valve, and in which the median element is a narrow bar, smooth or finely crenulate, with, at its anterior end, attached but below it, a rounded strongly projecting tooth." Sylvester-Bradley apparently was unable to locate the original "Challenger" types; though he noticed that Brady and Norman figured a species distinct from *Cythere scabrocuneata* Brady 1880, he ignored Brady's 1898 specimens—the very ones on which the genus was based. Indeed Sylvester-Bradley increased the already considerable confusion by describing and figuring five "paratype" specimens of *Cythere scabrocuneata* from the "Challenger" collection, Station 233 B, Inland Sea, Japan. These are larger than those described by Brady in 1880 (p. 113)—Sylvester-Bradley's specimens reach a maximum length of 1.10 mm. while Brady's are only 0.77 mm.—and are spinose while those on which Brady based his genus are nodose. We must conclude, therefore, that these specimens represent still another species, distinct from both of those figured by Brady in 1880, from *C. scabrocuneata* of Brady and Norman, and also from *T. scabrocuneata* Brady of 1898.

Because Brady's original specimens of *Cythere scabrocuneata* represent two species, neither of which is identical with Sylvester-Bradley's "paratypes," it seems best to take Brady's 1898 specimens as the actual genotypes. At least the locality from which the specimens figured is given. The author, however, does not know for sure whether these genotypes are still in existence, nor where they are deposited, and will therefore refer to the genus as *Trachyleberis* (?).

Localities.—Listed below are the localities from which samples used in this study were collected. Reference to location contained in the text are indicated by the index number which precedes each entry.

EOCENE

1. *Weches.*—Exposures along the banks of Colorado River at Smithville, Bastrop County, Texas. 2. *Cook Mountain.*—NE¼ NE¼ Sec. 22, T. 10 N., R. 5 W., Winn Parish, Louisiana. 3. *Cook Mountain.*—Little Brazos River, 200 yards north of lod bridge

on Highway No. 21 between Bryan and Stone City, Texas. 4. *Jacksonian.*—Creole Bluff on the Red River at Montgomery, Louisiana. 5. *Lower Jacksonian.*—Gibson Landing on the Ouachita River, Caldwell Parish, Louisiana. 6. *Lower Jacksonian.*—Ten feet below the *Corbula* bed in the bluffs of the Chickasawhay River, Hiwanee, Mississippi.

OLIGOCENE

7. *Vicksburg.*—Approximately one mile south of Carter Landing on the Ouachita River. 200 yards west (up the hill side) from the residence of Mr. Williams, NW¼ Sec. 25, T. 11 N., R. 5 E., Catahoula Parish, Louisiana. 8. *Vicksburg.*—On cleared, but abandoned right of way for proposed route of State Highway No. 111, 2.6 miles southeast of Leslie H. Day's residence (on old Columbia-Harrisburg Road, 2.1 miles southeast of Rosefield Cemetery), Sec. 35, T. 11 N., R. 5 E., Catahoula Parish, Louisiana. 9. Vicksburg.—Under the highway bridge at Rosefield Cemetery, Louisiana. One foot below the shell bed at the base of the logging railroad cut, Sec. 31, T. 11 N., R. 5 E. 10. *Vicksburg.*—150 feet upstream from the highway bridge over Chickasawhay River, ¼ mile west of Woodwards, NW¼ Sec. 2, T. 8 N., R. 7 W., Waynes Co., Mississippi.

MIOCENE

11. *Chipola.*—NE¼ NE¼ Sec. 20, T. 1 N., R. 16 W., Washington Co., Florida. 12. *Chipola.*—SE¼ SE¼ Sec. 8, T. 3 N., R. 16 W., Chimney Quarry, Washington Co., Florida. 13. *Chipola.*—SE¼ SE¼ Sec. 5, T. 1 N., R. 16 W., Washington Co., Florida. 14 *Chipola.*—1 mile below Scotts Bridge, NE¼ Sec. 27, T. 2 N., R. 12 W., Bay Co., Florida. 15. *Chipola.*—In a ravine 200 yards east of Holmes Creek, NW¼ NE¼ Sec. 28, T. 2 N., R. 16 W., Washington Co., Florida. 16. *Chipola.*—220 yards below Walsingham Bridge, NE¼ Sec. 15, T. 1 N., R. 13 W., Washington Co., Florida. 17. *Chipola.*—1 mile above Gainer's Bridge NW¼ Sec. 34, T. 1 N., R. 13 W., Washington Co., Florida. 18. *Chipola.*—NE¼ SW¼ Sec. 28, T. 2 N., R. 16 W., Washington Co., Florida. 19. *Chipola.*—At Red Head Still, NE¼ NW¼ Sec. 20, T. 1 N., R. 16 W., Washington Co., Florida. 20. *Chipola.*—Lassiter Landing on Choctawhatchee River, SE¼ SE¼ Sec. 13, T. 2 N., R. 17 W., Washington Co., Florida. 21. *Chipola.*—One and three-quarter miles below Scott's Bridge over Econfina Creek (? NE¼ NW¼ Sec. 28, T. 2 N., R. 12 W.), Bay Co., Florida. 22. *Chipola.*—Ten Mile Creek- Calhoun Co., Florida. 4 miles south of Willis, Florida. Coll. by Carroll Cook, Standard Oil Company (N. J.). 23. *Type Chipola.*—Ten Mile Creek, from bridge to one-half mile below bridge on the Marianna-Clarksville Road, 22 miles south of Marianna, Calhoun Co., Florida. 24. *Type Oak Grove.*—At Old saw-mill near Oak Grove on right bank of Yellow River about 100 yards below bridge on Laurel Hill-Oak Grove road, Okaloosa Co., Florida. 25. *Oak Grove.*—Senterfiet's or Tanner's Mill (abandoned), four miles southwest of Laurel Hill, Okaloosa Co., Florida. 26. *Shoal River.*—Small gully, 50 feet south of road and 150 feet east of bridge over White's Creek on Eucheeana-Knox Hill road, one mile west of Valley Church, Walton Co., Florida. 27. *Shoal River.*—Small branch ¼ mile southeast of residence of J. T. G. McClellan, being about ⅜ mile west of shell bluff on Shoal River which is the type locality. Coll. by Karl E. Young. 28. *Type Yoldia* Zone.—Frazier's farm, SE¼ of Sec. 18, T. 2 N., R. 19 W., Walton Co., Florida. 29. *Yoldia* Zone.—Upper 10 feet of material exposed at a small dripping spring on the Chester Spence farm, NE¼ NE¼ Sec. 17, T. 2 N., R. 19 W., Walton Co., Florida. 30. *Arca* Zone.—W. E. Collin's farm, SE¼ NE¼ Sec. 15, T. 2 N., R. 15 W., Washington Co., Florida. 31. *Arca* Zone.—SW¼ NE¼ SW¼ Sec. 16, T. 2 N., R. 15 W., Washington Co., Florida. 32. *Arca* Zone.—NW¼ SE¼ Sec. 16, T. 2 N., R. 15 W., Spring head, 100 yards east of road, Washington Co., Florida. 33. *Arca* Zone.—SW¼ NW¼ Sec. 15, T. 2 N., R. 15 W., Washington Co., Florida. 34. *Arca* Zone.—SE¼ SW¼NE¼ Sec. 15, T. 2 N., R. 15 W., Washington Co., Florida. 35. *Arca* Zone.—NW¼ SW¼ Sec. 15, T. 2 N., R. 15 W., Washington Co., Florida. 36. *Arca* Zone.—NE¼ SE¼ Sec. 16, T. 2 N., R. 15 W., Washington Co., Florida. 37. *Arca* Zone.—Flournoy's old mill, NE¼ Sec. 34, T. 3 N., R. 18 W., at an elevation of 164 feet, Holmes Co., Florida. 38. *Choctawhatches.*—Pit of West Florida Power Company, just east of road at Power dam, being about 300 feet east of the Hydroelectric power near Ward, Florida. Collected by Karl E. Young. 39. *Ecphora* (?).—300 feet above Walsingham Bridge over Econfina Creek, NE¼ Sec. 15, T. 1 N., R.

13 W., Washington Co., Florida. 40. *Ecphora* Zone.—½ mile above Walsingham Bridge, SW¼ Sec. 11, T. 1 N., R. 13 W., Washington Co., Florida. 41. *Ecphora* Zone.—¼ mile above Walsingham Bridge, SE¼ Sec. 10, T. 1 N., R. 13 W., Washington Co., Florida. 42. *Ecphora* Zone (?).—220 yards above Walsingham Bridge, Econfina Creek, NE¼ Sec. 15, T. 1 N., R. 13 W., Washington Co., Florida. 43. *Ecphora* Zone.—Type locality at Alum Bluff, left bank of Apalachicola River, Liberty Co., Florida. 44. *Ecphora* Zone, *Jackson* Bluff.—Near top of section, Ocklocknee River, Leon Co., Florida. 45. *Ecphora* Zone, *Jackson* Bluff.—Top shell bed, Ocklocknee River, Leon Co., Florida. 46. *Ecphora* Zone, *Pecten* Bed.—Jackson Bluff, Ocklocknee River, Leon Co., Florida. 47. *Ecphora* Zone.—Harvey Creek ½ mile above old well at "Swimming Hole" (5 feet below water), Leon Co., Florida. 48. *Cancellaria* Zone.—Gully pond, southeast of Greenhead, Washington Co., Florida, on the Sales-Davis Lumber Company Property in the center of N½ NW¼ Sec. 14, T. 1 N., R. 14 W., at approximate elevation of 59 feet. 49. *Cancellaria* Zone.—In a small sink south of a community road in the NW¼ SW¼ Sec. 7, T. 1 N., R. 13 W., Washington Co., Florida. 50. *Cancellaria* Zone.—One quarter mile below Gainer's Bridge, Econfina Creek, SW¼ SE¼ Sec. 33, T. 1 N., R. 13 W., Washington Co., Florida. 51. *Cancellaria* Zone.—Blue Sink Center of NE¼ Sec. 14, T. 1 N., R. 14 W., Washington Co., Florida. 52. *Cancellaria* Zone.—Clarke's Pond, NE¼ SE¼ SW¼ Sec. 12, T. 1 N., R. 12 W., Washington Co., Florida. 53.

TABLE 1.—Range of the genus *Trachyleberis* (?) in the Cenozoic of the Gulf Coast. Species are listed according to the generic names under which they were described

Species \ Formations	Eocene			Oligocene	Recent
	Weches	Lower Jackson	Upper Jackson	Vicksburg	Recent
Cythere bahamensis Brady					▬
Cythereis rosefieldensis Howe and Law				▬	
Cythereis quadrataspinata Howe and Law				▬	
Cythereis dacyi Howe and Law				▬	
Cythereis thomsoni Howe and Law				▬	
Cythereis montgomeryensis Howe and Chambers		▬	▬		
Cythereis grigsbyi Howe and Chambers		▬	▬		
Cythereis splendens Sutton and Williams	▬				
Cythereis linospinosa Sutton and Williams	▬				
Cythereis smithvillensis Sutton and Williams	▬				

Cancellaria Zone.—In a small stream south of, and under Gainer's Bridge, SW¼ SE¼ Sec. 33, T. 1 N., R. 13 W., Washington Co., Florida. 54. *Cancellaria* Zone.—½ mile above Gainer's Bridge, SE¼ NE¼ Sec. 33, T. 1 N., R. 13 W., Washington Co., Florida. 55. *Cancellaria* Zone.—330 yards above Gainer's Bridge, on Econfina Creek, NE¼ SE¼ Sec. 33, T. 1 N., R. 13 W., Washington Co., Florida. 56. *Cancellaria* Zone.—NE¼ Sec. 16, T. 1 S., R. 13 W., on Moccasin Creek Beneath Bridge, Bay Co., Florida.

RECENT

57. Lime mud flat on south side of New Providence Island, at ebb tide.

SYSTEMATIC PALEONTOLOGY

Genus TRACHYLEBERIS (?) Brady

Genotype: Trachyleberis scabrocuneata (Brady 1898).

Description.—Carapace elongate-subquadrate, greatest height at the anterior, about half the length. Anterior end broadly rounded, denticulate; posterior end narrow and compressed, irregularly emarginate. Dorsal margin broken into an irregular jagged line, ventral margin nearly straight. Seen from the dorsal side, the outline is subovate and compressed. Surface of the carapace covered with large irregularly rounded nodules or spines not arranged in any definite pattern. Marginal area broad, marginal pore canals numerous, wavy and thickened in the middle. Muscle scar pattern simple with four muscle scars arranged vertically posterior to the central node and a curved muscle scar situated anteriorly. Hinge in the right valve with strongly smooth or finely crenulate projecting narrow bar.

Range: Eocene to Recent.

TRACHYLEBERIS (?) QUADRATASPINATA (Howe and Law)

Plate 1, figs. 1, 2

Cythereis quadrataspinata Howe and Law, 1936, page 50, plate 3, figs. 30-32; plate 4, fig. 3. Vicksburg Oligocene, Louisiana.

Remarks.—This species was originally described from the Vicksburg at Carter Landing, Locality 7. The most characteristic feature of this species is the large number of quadrate spines around the anterior, ventral and posterior margins.

Dimensions of topotype no. 998, a left valve: length .845 mm.; height .405 mm.; topotype no. 999, a right valve: length .845 mm.; height .422 mm. All figured specimens came from Locality 7.

TRACHYLEBERIS (?) ROSEFIELDENSIS (Howe and Law)

Plate 1, fig. 3

Cythereis rosefieldensis Howe and Law, 1936, page 51, plate 3, fig. 26; plate 4, figs. 1, 2. Vicksburg Oligocene, Louisiana. *Cythereis spinosa* Van den Bold (not Lienenklaus) 1946, page 90, plate 10, fig. 10. *Cythereis rosefieldensis* Van den Bold 1950, page 107, 108. Oligocene Cuba.

Remarks.—This species was originally described from the Vicksburg at Locality 8. The surface of the carapace shows an irregular pattern of rounded spines of varying height, the most prominent being anterior to the center at the place of muscular attachment. This species is characterized by a very broad posterior marginal area bearing a tuft of elongated spines.

Dimensions of topotype no. 2410, a left valve from Locality 8: length .777 mm.; height .371 mm.

TRACHYLEBERIS (?) MONTGOMERYENSIS (Howe and Chambers)
Plate 1, figs. 4, 5; text figs. A, B

Cythereis montgomeryensis Howe and Chambers, 1935, page 37, figs. 13, 16; plate 2, figs. 22, 23; plate 6, figs. 19, 20. Jackson Eocene, Louisiana. Garrett 1936, page 786. Jackson Eocene, Alabama. Bergquist 1942, page 108, plate 11, figs. 15, 16. Stephenson 1944, page 450, plate 76, fig. 7. Reklaw Eocene, Bastrop Co., Texas. Van den Bold 1950, page 108. Upper Eocene, Cuba.

Description.—Carapace elongate-subquadrate; greatest height at the anterior cardinal angle. Dorsal margin nearly straight, ornamented with long, sharp, tapering spines; ventral margin slightly convex and ornamented with numerous but smaller and shorter spines. The dorsal and the ventral margins are subparallel and tend to converge at the posterior end. Anterior end broadly rounded, the greatest curvature being just below the middle; upper portion oblique with a distinct marginal rim ornamented with a row of generally short and sharp spines. Posterior end very compressed, narrow, angular and denticulate; dorsal portion almost straight, ventral slightly concave. Surface of the carapace ornamented with sharp, vertically tapering, irregularly arranged spines of varying size, some being quite long. Viewed from inside the valves are shallow and translucent so that the external ornamentation is visible. Marginal area broad, broadest at the anterior, with several infolded "lip-lines." Radial pore canals numerous, long, wavy, sometimes branched and thickened in the middle, more numerous in the anterior than in the posterior marginal area. Hinge in the right valve with an anterior smooth tooth, a postjacent socket and a posterior socket connected by a deep groove.

Dimensions of topotype no. 2411, a right valve: length .811 mm.; height .405 mm.; topotype no. 2412, a complete specimen: length .828 mm.; height .439 mm. Figured specimens came from Locality 4.

TRACHYLEBERIS (?) THOMSONI (Howe and Law)
Plate 1, figs. 6-8

Cythereis thomsoni Howe and Law, page 53, plate 4, fig. 7; plate 5, figs. 8-10. Vicksburg Oligocene, Louisiana.

Remarks.—This species was originally described from the Vicksburg at Rosefield Cemetery, Locality 9. Surface ornamentation of the carapace consists of irregularly arranged welts. This species is related to *T. (?) grigsbyi* of the Jackson (Eocene) but differs from it in having the welts just above the middle of the ventral margin divided into two parts. *T. (?) thomsoni* also has more prominent swelling at the posterior cardinal angle.

Dimension of topotype no. 2413, a complete specimen: length .743 mm.; height, .354 mm.; topotype no. 2414, a right valve: length .709 mm.; height .358 mm. All figured specimens came from Locality 9.

TRACHYLEBERIS (?) GRIGSBYI (Howe and Chambers)
Plate 1, figs. 9, 10

Cythereis grigsbyi Howe and Chambers, 1935, page 30, plate 1, figs. 17, 18; plate 2, fig. 20; plate 6, fig. 6. Jackson Eocene, Louisiana. Monsour 1937, page 89, Jackson Eocene, Mississippi.

Remarks.—This species was described from the Upper Jacksonian Eocene of the Chickasawahy River, Hiwanee, Locality 6. The surface of the carapace shows a characteristically irregularly nodose pattern. The most diagnostic

feature of this species is a low swelling just in front of the center but separated from it by a shallow, arcuate median sulcus.

Dimensions of topotype no. 2415, a right valve: length .794 mm., height .422 mm.; topotype no. 2416, a left valve: length .946 mm.; height .405 mm. Figured specimens came from Locality 6.

TRACHYLEBERIS (?) DACYI (Howe and Law)

Plate 1, fig. 11

Cythereis dacyi Howe and Law, 1936, page 45, plate 4, fig. 6; plate 5, figs. 3, 4. Vicksburg Oligocene, Louisiana. Kingma 1948, page 79, plate 9, fig. 4. Pliocene, East Java.

Remarks.—This species was originally described from the Vicksburg Oligocene of Carter Landing on the Ouachita River, Locality 7. The most characteristic feature is the major set of lateral welts which is divided into two series by a small gap near the middle. *T.* (*?*) *dacyi* is distinguished from related Jackson species by the fact that anterior series consists of four swellings from the anterior series. The double row of spines along the junction of the valves is another diagnostic feature.

Dimensions of topotype no. 2417, a right valve from Locality 7: length .760 mm., height .388 mm.

TRACHYLEBERIS (?) SPLENDENS (Sutton and Williams)

Plate 1, figs. 12, 13

Cythereis splendens Sutton and Williams, 1939, page 563, plate 63, figs. 12-14. Weches Eocene, Smithville, Texas. Not *Cythereis splendens* Van den Bold, 1946, page 94, Paleocene of Guatemala = *Cythereis davidwhitei* Stadnichenko by Van den Bold 1950, page 107. Stephenson 1946, page 340, plate 44, fig. 6; plate 45, fig. 10. Weches Eocene, Smithville, Texas. *Cythereis cf. Cythereis splendens* Swain 1948, page 205, plate 14, fig. 11. Hammond Well, Maryland. 1260-70 feet. Eocene.

Description.—Carapace elongate; greatest height at the anterior cardinal angle. Dorsal and ventral margins nearly straight in the left valve; ventral margin in the right valve sinuate. Anterior end broadly rounded; posterior end narrow and compressed, with a prominent posterodorsal angulation. Surface of the carapace irregularly nodose, with a promnient node just anterior to the middle. On the ventral half of the carapace the spines tend to run in an oblique row starting at the anteroventral margin and extending upward toward the posterior end. Viewed from inside the valves are moderately deep with broad marginal areas. Hinge normal to the genus.

Dimensions of topotype no. 2418, a complete specimen: length .929 mm.; height .422 mm. The figured specimens came from Locality 1.

TRACHYLEBERIS (?) SMITHVILLENSIS (Sutton and Williams)

Plate 1, fig. 14

Cythereis smithvillensis Sutton and Williams, 1939, page 564, plate 63, figs. 18-20. Weches. *Cythereis orelliana* Stephenson (part), 1946, page 338, plate 45, fig. 20. Weches. *Cythereis smithvillensis* Stephenson, 1947, pages 580, 581. Wicox, Weches.

Remarks.—This species was originally described from the Weches Eocene, Locality 1. It resembles *T.* (*?*) *splendens* in general shape but differs from it in having parallel dorsal and ventral margins; those of *T.* (*?*) *splendens* converge to the posterior end. The surface of *T.* (*?*) *splendens* has only scat-

tered nodose spines but *T.* (*?*) *smithvillensis* has intricate network of vertically tapering spines.

Dimensions of topotype no. 2420, a left valve: length .878 mm.; height .422 mm. Figured specimens came from the Weches Eocene, Locality 1.

TRACHYLEBERIS (?) LINOSPINOSA (Sutton and Williams)

Plate 1, figs. 15, 16

Cythereis linospinosa Sutton and Williams, 1939, page 566, plate 63, figs. 5, 6. Weches Eocene, Smithville, Texas. Stephenson 1946, page 338, plate 45, fig. 18. Weches Eocene, Smithville, Texas.

Remarks.—This species was originally described from the Weches Eocene, Locality 1. It has a characteristic subquadrate carapace ornamented by scattered spines and nodes, with a prominent nodose area just anterior to the middle.

Dimensions of topotype no. 2421, a left valve: length .845 mm.; height .473 mm.; topotype no. 2422, a right valve: length .845 mm.; height .439 mm. Figured specimens came from Locality 1.

TRACHYLEBERIS (?) BAHAMENSIS (Brady)

Plate 1, fig. 17; text fig. G

Cythere bahamensis Brady 1870, Fonds, page 241, plate 32, figs. 1, 2. *Cythere bahamensis* Muller, 1912, page 362.

Description.—Carapace subquadrate, highest at the anterior. Dorsal margin nearly straight, ventral slightly concave. Anterior end broadly rounded, denticulate, with a raised marginal ridge ornamented by eight to ten small spines. Posterior end broadly rounded toward the dorsal margin, slightly oblique toward the ventral. Surface of the carapace ornamented with short scattered spines which show a slight tendency to linear arrangement near the dorsal and ventral margins. Slightly anterior to the center is a thick node which tends to break into several small spines. Viewed from inside, the valves are moderately deep with broad marginal areas. Hinge normal to the genus.

Dimensions of plesiotype no. 2423, a left valve: length .743 mm., height .371. Figured specimens came from New Providence Island, Locality 57.

Genus **Actinocythereis** gen. nov.

Genotype: *Cythere exanthemata* Ulrich and Bassler, 1904.

Description.—Carapace oblong-subquadrate. Anterior end obliquely rounded, strongly denticulate with a well-developed marginal rim; posterior end obliquely rounded, denticulate, fringed with a double row of spiny tubercles. Dorsal margin broken into an irregular jagged line; ventral margin with a few spiny tubercles. Surface of the carapace ornamented with three distinct rows of vertically elongated spines. Marginal area broad, with a lipline and many paired marginal pore canals which generally are straight, sometime are wavy, but never are thickened. Muscle scar pattern consists of four oval spots in a vertical row, a fifth is in front of the middle and a sixth is below it. Hinge of the right valve consists of an anterior tooth, a postjacent socket and a posterior tooth, connected by a shallow median groove.

Range: Eocene to Miocene.

ACTINOCYTHEREIS EXANTHEMATA (Ulrich and Bassler)

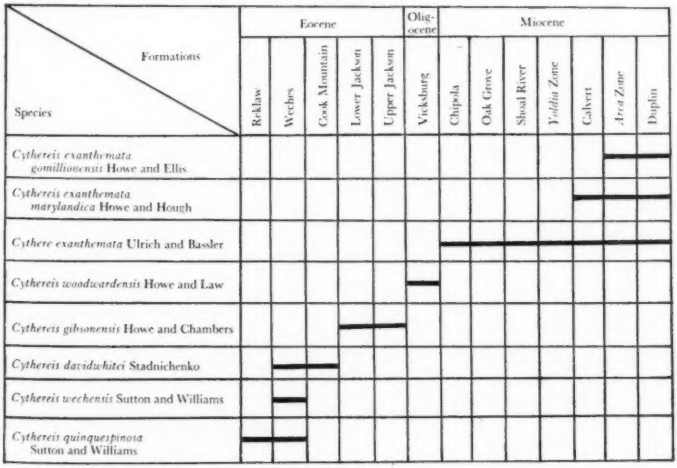
Plate 2, figs. 4-8. Text figs. E, F

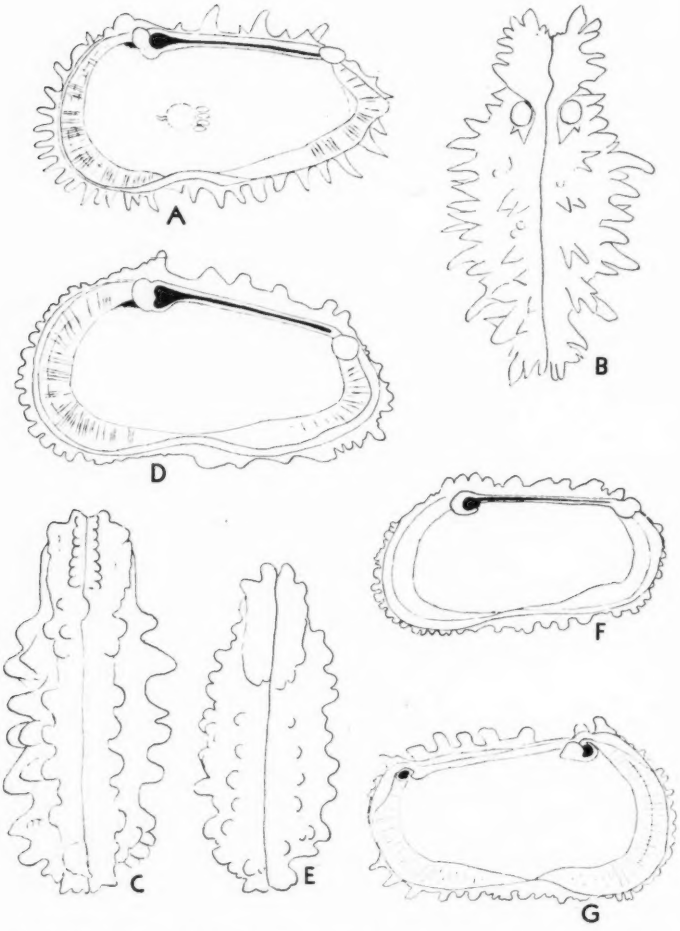
Cythere exanthemata Ulrich and Bassler, 1904, page 117, plate 36, figs. 1-5. Choptank, Pawpaw Point; Calvert; Plum Point; Chesapeake on James River and Yorktown. vars. A. B. Smith 1941, page 279. Van den Bold 1946, page 88, plate 10, fig. 2, Mio. Cuba, Guatemala. Swain 1948, page 204, plate 12, figs. 14, 15. Hammond Well, Maryland.

Description.—Carapace oblong-subquadrate, obliquely rounded at the ends, the greater curvature at the middle of the anterior and the posterior ends. Dorsal margin jagged with spines; ventral nearly straight with a few obscure spiny tubercles which are smaller than the dorsal ones. Anterior end with a well defined marginal rim. Posterior end compressed and ornamented with a double fringe of spines. Surface of the carapace ornamented with three distinct rows of vertically tapering spines. The dorsal row parallels the dorsal margin and the spines project over it. The median and most prominent row starts at the subcentral tubercle and continues obliquely across the central portion toward the posterior cardinal angle, where a vertical row of three to four spines connects it with the dorsal row. The ventral row of spines, which is situated just above the ventral margin, runs almost parallel to the middle row.

Viewed from inside the valves are moderately shallow and thick. Marginal area moderately broad, broadest at the anterior, with two "lip-lines" which are infolded. Radial pore canals are numerous, mostly straight but sometimes wavy, paired, thickened and frequently crossing. Hinge of the

TABLE II.—Range of the genus *Actinocythereis* in the Tertiary of the Gulf Coast. Species are listed according to the generic name under which they were originally described.





Text figs. A-G.—A, B. *Trachyleberis* (?) *montgomeryensis* (Howe and Chambers). A. a right valve, topotype no. 2411; B. dorsal view of a complete specimen, topotype no. 2412. C, D. *Actinocythereis exanthemata marylandica* (Howe and Ellis); C. dorsal view of a complete specimen, plesiotype no. 2426; D. right valve view of the same specimen. E, F. *Actinocythereis exanthemata* (Ulrich and Bassler). E. dorsal view of a complete specimen, plesiotype no. 2429; F. a right valve, plesiotype no. 2427. G. *Trachyleberis* (?) *bahamensis* (Brady), a left valve, plesiotype no. 2423. All figures ×45.

right valve has an anterior projecting tooth, a postjacent socket and a posterior oval tooth connected by a shallow groove.

Dimensions of plesiotype no. 2427, a right valve from Locality 44: length .676 mm.; height .354 mm.; plesiotype no. 2428, a complete specimen from Locality 11: length. 608 mm.; height .371 mm.; plesiotype no. 2429, a complete specimen from Locality 44: length .828 mm.; height .338 mm.; plesiotype no. 2830, a right valve from Locality 44: length .692 mm.; height .287 mm.; plesiotype no. 2831, a right valve from Locality 23: length .591 mm.; height .287 mm.

This species occurs at the Chipola localities nos. 11, 13, 14, 15, 16, 17, 21, and 22: Oak Grove Locality no. 24; Shoal River Locality 26; *Arca* zone of the Choctawhatchee localities nos. 31, 36 and Duplin marl localities nos. 39, 40, 41, 42, 44, 45, 50, 51, 52, 53, and 56.

Remarks.—This species was originally described from the Calvert Miocene of Maryland. The Florida specimens from the Duplin marl localities certainly belong to this speices which has not been reported from the Florida Miocene before. There is, however, a smaller form in the Chipola which differs from the Duplin representatives of this species in not having a well-developed double fringe of spines at the posterior. The median row of spines in the Chipola specimens is not as fully developed as in those from the Duplin marl. These forms are here included in *A. exanthemata* because minor variations occur within this species in the Oak Grove, Shoal River and the *Arca* and *Yoldia* zones of the Choctowhatchee formation. This species was gradually evolved from an ancestral stock before the Paynes Hammock times as this species is present in the Paynes Hammock sands of Mississippi.

ACTINOCYTHEREIS EXANTHEMATA MARYLANDICA (Howe and Hough)

Plate 2, fig. 3. Text figs. C, D

Cythereis exanthemata marylandica Howe and Hough, in Howe et al. 1935, page 18, plate 1, figs. 1-5; plate 4, fig. 7, Plum Point, Maryland; *Arca* Zone; Up. Choctawhatchee.

Remarks.—This variety was originally described from the Calvert Miocene of Maryland. It differs from the typical form in being much higher and more coarsely ornamented.

Dimensions of plesiotype no. 2426, a right valve from Locality 44: length 1.014 mm.; height .490 mm. The figured specimen came from the *Ecphora* Zone Locality 44.

This variety also occurs in the *Arca* zone Localities 31 and 36 at the *Ecphora* zone Localities 39 and 45.

ACTINOCYTHEREIS EXANTHEMATA GOMILLIONENSIS (Howe and Ellis)

Plate 2, figs. 1, 2

Cythereis exanthemata gomillionensis Howe and Ellis, in Howe et al. 1935, page 119, plate 1, figs. 6-12, plate 4, fig. 3. *Arca* Zone Mio., Florida. Edwards 1944, page 521, plate 87, figs. 31, 32. Duplin Mio., N. Car. Van den Bold 1946, page 88, plate 9, fig. 19. Mio., Cuba, Guatemala. Van den Bold 1950, page 83, Mio., Venezuela.

Remarks.—This variety was originally described from the *Arca* zone of the Choctawhatchee Miocene of Florida. It differs from *A. exanthemata marylandica* in its much smaller size, more elongate form, and more delicate ornamentation. A supplementary row of very fine spines along the hinge of

the right valve distinguishes this variety from both the typical species and the variety *marylandica*.

Dimensions of plesiotype no. 2424, a left valve: length .625 mm.; height .304 mm.; plesiotype no. 2425, a right valve: length. 777 mm.; height .371 mm. Figured specimens came from the *Arca* Zone, Locality 30.

This variety also occurs in the *Arca* zone at Localities 31, 32, 33, 34 and 36 and in the *Ecphora* zone at Locality 41.

ACTINOCYTHEREIS WOODWARDENSIS (Howe and Law)

Plate 2, fig. 9

Cythereis woodwardensis Howe and Law, 1936, page 56, plate 3, figs. 27-29; plate 4, fig. 5. Vicksburg Oligocene, Louisiana.

Description.—Carapace elongate with dorsal and ventral margins sinuous. Surface of the carapace ornamented with three rows of irregular nodes. The dorsal row, which is near the dorsal margin, is conspicuously curved and the nodes are fused so as to give it the appearance of an irregular rim. The central row extends irregularly along the middle. The ventral row begins at a point near the junction of the anterior and ventral margins and extends obliquely upward and backward toward the posterior. Viewed from inside, the valves are moderately deep, with comparatively narrow marginal areas. Because of the narrow marginal area, the radial pore canals are short. They commonly occur in pairs around the anterior end.

Dimensions of topotype no. 2832, a complete specimen from Locality 10: length .709 mm.; height .354 mm.

This species was originally described from the Vicksburg Oligocene, Locality 10.

ACTINOCYTHEREIS DAVIDWHITEI (Stadnichenko)

Plate 2, fig. 10

Cythereis davidwhitei Stadnichenko, 1927, page 240, plate 39, fig. 24, Cook Mountain Eocene, Evergreen, Orell. Stephenson 1946, page 336, plate 44, fig. 5; plate 46, fig. 12. Weches Eocene, Smithville, Texas. *Cythereis splendens* Van den Bold 1946, page 94. Paleocene, Guatemala. *Cythereis davidwhitei* Van den Bold 1950, pages 107, 108. L. Eocene, Cuba.

Description.—Carapace small, elongate-ovate; greatest height at the anterior end. Dorsal and ventral margins nearly straight and parallel. Anterior end broadly rounded with a raised ridge; convex toward the ventral margin, oblique over the ventral margin. Posterior end narrow, depressed, angular and strongly crenulate. Surface of the carapace ornamented with three rows of long, vertically tapering spines.

Dimensions of plesiotype no. 2833, a right valve from Locality 1: length .743 mm.; height .304 mm.

ACTINOCYTHEREIS GIBSONENSIS (Howe and Chambers)

Plate 2, figs. 11, 12

Cythereis gibsonensis Howe and Chambers, 1935, page 29, plate 1, fig. 22; plate 6, figs. 21, 22. Jackson Eocene, Louisiana. Garrett 1936, page 786. Jackson Eocene, Alabama. Monsour 1937, page 89. Jackson Eocene, Mississippi. Bergquist 1942, page 107, plate 11, figs. 9, 10.

Description.—Carapace elongate with straight dorsal and ventral margins

which converge gently toward the posterior end. Surface of the carapace ornamented with coarse spines arranged in two rows. The dorsal row starts just in front of the center and extends backward in the general direction of the posterior cardinal angle. The ventral row runs parallel to the dorsal row above the ventral margin. Viewed from inside, the valves are moderately shallow. Marginal area around the anterior, ventral and posterior sides is rather wide. The radial pore canals are numerous, grouped in pairs or sometime in threes at the anterior end.

Dimensions of topotype no. 2834, a right valve: length .709 mm.; height .321 mm.; topotype no. 2835, a left valve: length .811 mm.; height .321 mm. Figured specimens came from Locality 5.

ACTINOCYTHEREIS QUINQUESPINOSA (Sutton and Williams)

Plate 2, fig. 13

Cythereis quinquespinosa Sutton and Williams, 1939, page 566, plate 63, figs. 10, 11. Weches Eocene, Smithville, Texas.

Description.—Carapace ovate-angulate, with the valves flatly compressed. Greatest height at the anterior cardinal angle. Dorsal margin straight, ventral margin markedly convex. Both dorsal and ventral margins strongly converge posteriorly so as to give the carapace a subtriangular shape. Anterior end broadly rounded; posterior angulate. Carapace ornamented by three longitudinal rows of short, stubby spines. The dorsal row contains six short, backwardly pointing spines; the median row consists of five well pronounced spines; the ventral row consists of four spines which are thick and broadly rounded. There is a prominent glassy eye spot at the anterior cardinal angle. Viewed from inside, the valves are shallow with broad marginal areas at both ends. Hinge normal to the genus.

Dimensions of plesiotype no. 2836, a right valve from Locality 1: length .692 mm.; height .405 mm.

ACTINOCYTHEREIS WECHENSIS (Sutton and Williams)

Plate 2, figs. 14, 15

Cythereis spinosa Sutton and Williams, 1939, (*not* Lienenklaus 1900), page 563, plate 63, figs. 1-4. Weches Eocene, Smithville, Texas. *Cythereis wechensis* Sutton and Williams (nom. nov.), 1940, page 163. Stephenson 1946, page 342, plate 45, fig. 9. Weches Eocene, Smithville, Texas.

Description.—Carapace elongate-ovate; valves differently shaped. Left valve subquadrate; right valve somewhat more elongate. Dorsal margin almost straight; ventral margin sinuate. Anterior end broadly rounded; posterior somewhat angulate. Surface of the carapace ornamented with three distinct rows of short nodes. Most prominent of these is the ventral row which consists of seven spines and starts slightly anterior to the middle of the carapace and runs upward and backward toward the posterior.

Dimensions of plesiotype no. 2837, a right valve: length .760 mm.; height .405 mm.; plesiotype no. 2838, a right valve: length .726 mm.; height .388 mm. Figured specimens came from Locality 1.

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EXPLANATION OF PLATES

All figures are ×30. Type numbers refer to Henry V. Howe collection at Louisiana State University.

PLATE I

Figs. 1, 2. *Trachylebereis* (*?*) *quadrataspinata* (Howe and Law). 1, a left valve, topotype no. 998; 2, a right valve, topotype no. 999.

Fig. 3. *Trachyleberis* (*?*) *rosefieldensis* (Howe and Law), a left valve, topotype no. 2410.

Figs. 4, 5. *Trachyleberis* (*?*) *montgomeryensis* (Howe and Chambers). 4, a right valve, topotype no. 2411; 5, dorsal view of a complete specimen, topotype no. 2412.

Figs. 6, 7, 8. *Trachyleberis* (*?*) *thomsoni* (Howe and Law). 6, left valve view of a complete specimen, topotype no. 2413; 7, right valve view of the same specimen; 8, a right valve, topotype no. 2414.

Figs. 9, 10. *Trachyleberis* (*?*) *grigsbyi* (Howe and Chambers). 9, a right valve, topotype no. 2415; 10, a left valve, topotype no. 2416.

Fig. 11. *Trachyleberis* (*?*) *dacyi* (Howe and Law), a right valve, topotype no. 2417.

Figs. 12, 13. *Trachyleberis* (*?*) *splendens* (Sutton and Williams). 12, left valve view of a complete specimen, topotype no. 2418; 13, right valve view of the same specimen.

Fig. 14. *Trachyleberis* (*?*) *smithvillensis* (Sutton and Williams), a left valve, topotype no. 2420.

Figs. 15, 16. *Trachyleberis* (*?*) *linospinosa* (Sutton and Williams). 15, a left valve, topotype no. 2421; 16, a right valve, topotype no. 2422.

Fig. 17. *Trachyleberis* (*?*) *bahamensis* (Brady), a left valve, plesiotype no. 2423.

PLATE II

Figs. 1, 2. *Actinocythereis exanthemata gomillionensis* (Howe and Ellis). 1, a left valve, plesiotype no. 2424; 2, a right valve, plesiotype no. 2425.

Fig. 3. *Actinocythereis exanthemata marylandica* (Howe and Hough), a right valve, plesiotype no. 2426.

Figs. 4-8. *Actinocythereis exanthemata* (Ulrich and Bassler), 4, a right valve, plesiotype no. 2427; 5, left valve view of a complete specimen, plesiotype no. 2428; 6, dorsal view of a complete specimen, plesiotype no. 2429; 7, a right valve, plesiotype no. 2430; 8, a right valve, plesiotype no. 2431.

Fig. 9. *Actinocythereis woodwardensis* (Howe and Law), right valve view of a complete specimen, topotype no. 2832.

Fig. 10. *Actinocythereis davidwhitei* (Stadnichenko), a right valve, plesiotype no. 2433.

Figs. 11, 12. *Actinocythereis gibsonensis* (Howe and Chambers). 11, a right valve, topotype no. 2834; 12, a left valve, topotype no. 2835.

Fig. 13. *Actinocythereis quinquespinosa* (Sutton and Williams), a right valve, plesiotype no. 2836.

Figs. 14, 15. *Actinocythereis wechensis* (Sutton and Williams). 14, a right valve, plesiotype no. 2837; 15, a right valve, plesiotype no. 2838.

PLATE I

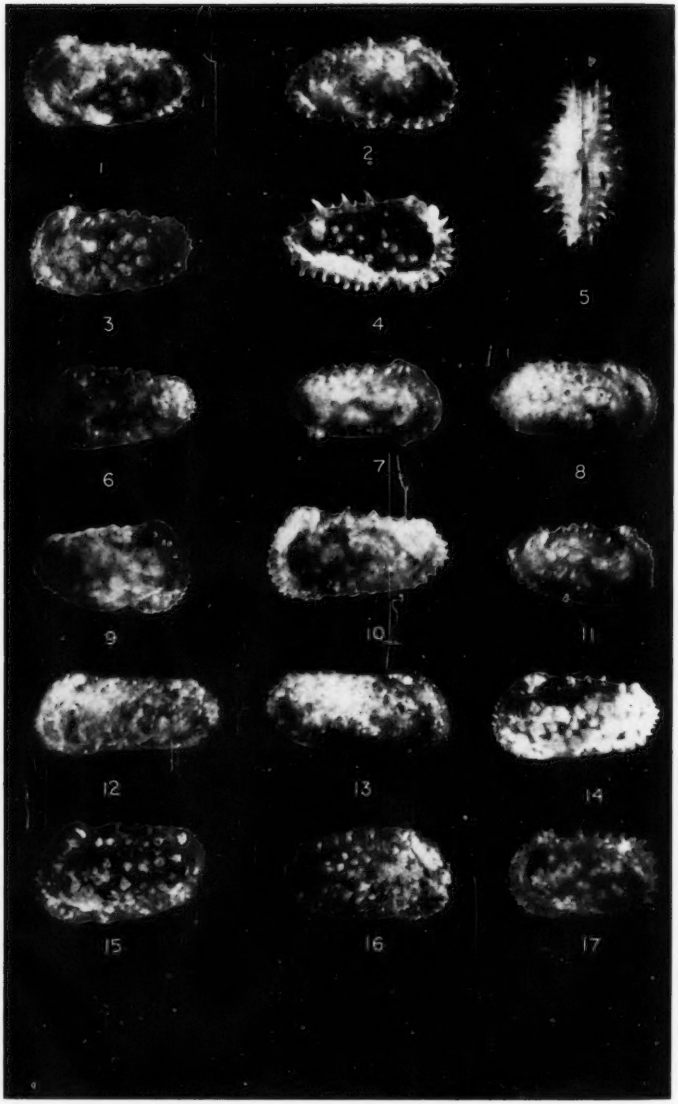
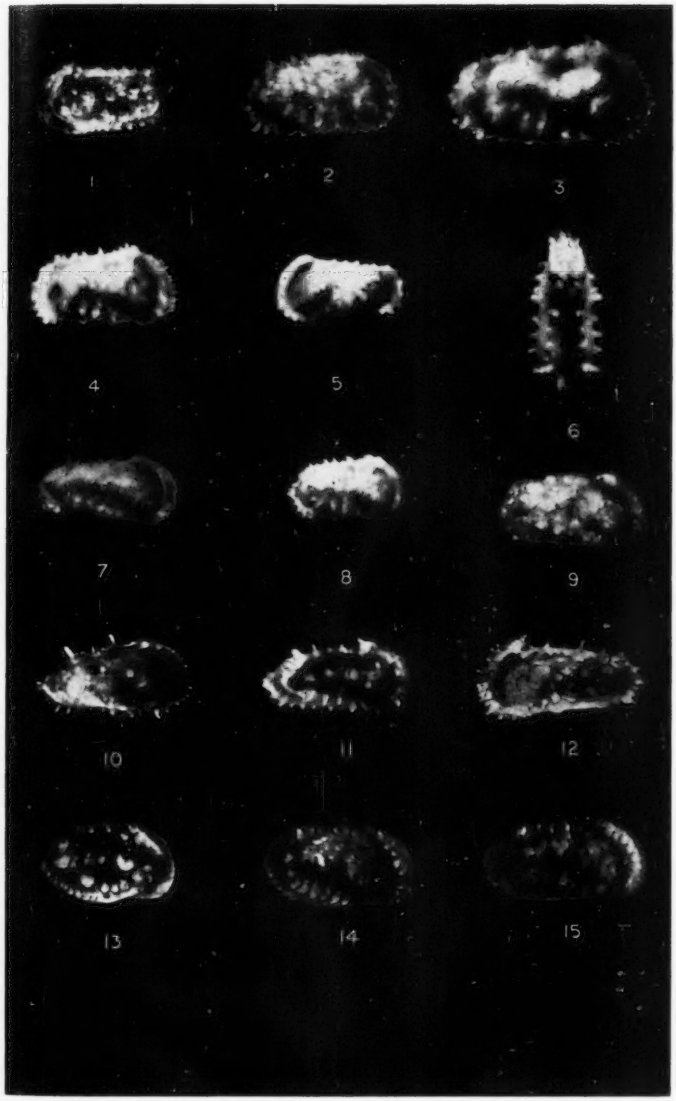


PLATE II



The Copepod Cyclops dimorphus Kiefer from the Salton Sea

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Plankton samples collected in the Salton Sea, California at irregular intervals since 1944 have consistently yielded a cyclopoid copepod belonging to the tribal section Bifida and the subgenus *Microcyclops* Claus as outlined by Gurney (1933:35).

The number of American species of this subgenus is apparently small. Marsh (1910) found only *Cyclops bicolor*. Wilson (1932) records *C. bicolor* and *C. varicans* under the genus *Microcyclops*. Kiefer (1931) lists the above two species and also *C. rubellus* which according to Sars (1918), Gurney (1933) and Yeatman (1944) is probably a variety of *C. varicans*. In 1934 Kiefer described a new species, *Cyclops dimorphus*, from material sent to him from the Salton Sea. He places the species in his subgenus *Metacyclops* which some authors (Gurney 1933; Yeatman 1944) do not consider distinct from the subgenus *Microcyclops* Claus.

Kiefer's description of *Cyclops dimorphus* is inadequate as already pointed out by Yeatman (1944, p. 72). There appears, however, to be no doubt that the species here dealt with is the one described by him since it is the only cyclopoid noted in the type area and there is agreement with the brief general diagnosis and with the figures of the fifth legs the only parts illustrated in the original description.

It is well, therefore, to give a complete description of the adult of this species, together with an account of the larval development. This is particularly desirable because of the probable bearing the present unusual environment may have on the structure of the species or may later induce should it continue to thrive in the Salton Sea, its new habitat.

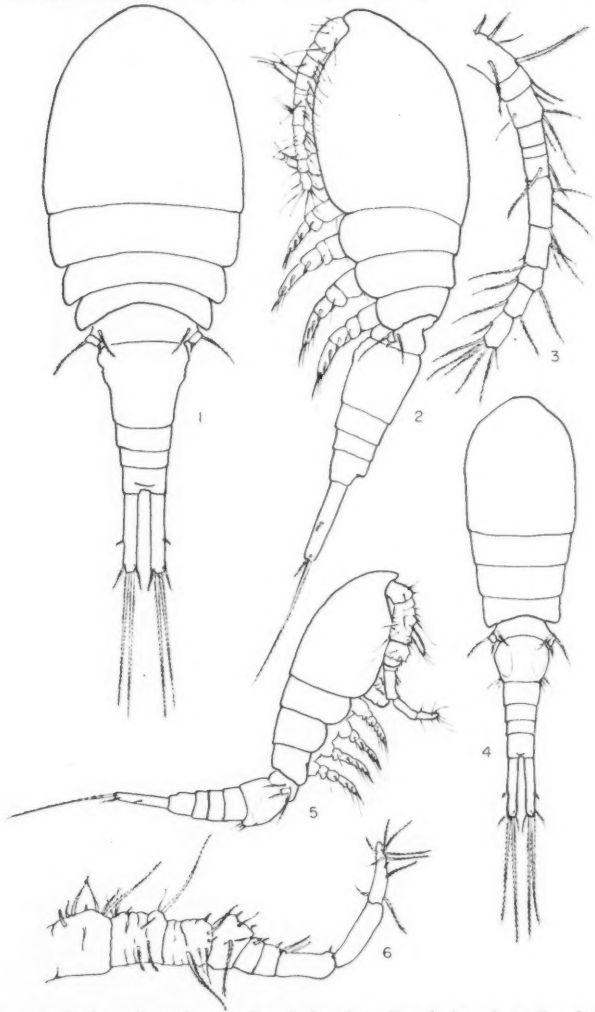
Coker (1934) has demonstrated that temperature differences may result in structural variations in certain species of *Cyclops*. Variations occurred in the relative proportions of the caudal rami, and a spine in lieu of a seta was formed on the outer border of the terminal segment of the fourth feet in more than half of the copepods reared at the lower temperatures. The effect of salinity variations or ionic ratios were not studied by Coker.

The Salton Sea is a large body of water lying 248 feet below sea level where it was formed during 1905 to 1907 by overflow of the Colorado River. Subsequent increase in salinity to near that of coastal sea water has resulted from leaching of salt from the old salt bed. Since the formation of this inland sea a number of exotic marine animals have been introduced notably a barnacle, a polychaete worm *Neanthes* and a tintinnid *Favella*. The barnacle appears to have undergone considerable change in shell structure when compared with the type first observed in the Salton Sea about 1942, and has

1 Contributions from Scripps Institution of Oceanography, New Series, No. 589.

recently been described as a new subspecies *Balanus amphitrite saltonensis* (Rogers, 1949).

The original habitat of *Cyclops dimorphus* has not been determined but it



Figs. 1-6. *Cyclops dimorphus*—1. Female-dorsal; 2. Female lateral; 3. Female-first antenna; 4. Male-dorsal; 5. Male-lateral; 6. Male-first antenna.

seems probable that it will be found in fresh or brackish water of the lower Colorado River.

Plankton tows were taken in Mead Lake (formed by damming of the Colorado River) in 1936 and 1937 and in the Colorado River at Yuma, Arizona and in the Alamo River near El Centro, California on Dec. 22, 1950. The Alamo River receives water from the Colorado River below Yuma and empties into the Salton Sea. *Cyclops dimorphus* was not found in any of these tows though all of them yielded other species of *Cyclops*.

CYCLOPS (MICROCYCLOPS) DIMORPHUS Kiefer, 1934

Figs. 1-18 (camera lucida drawings)

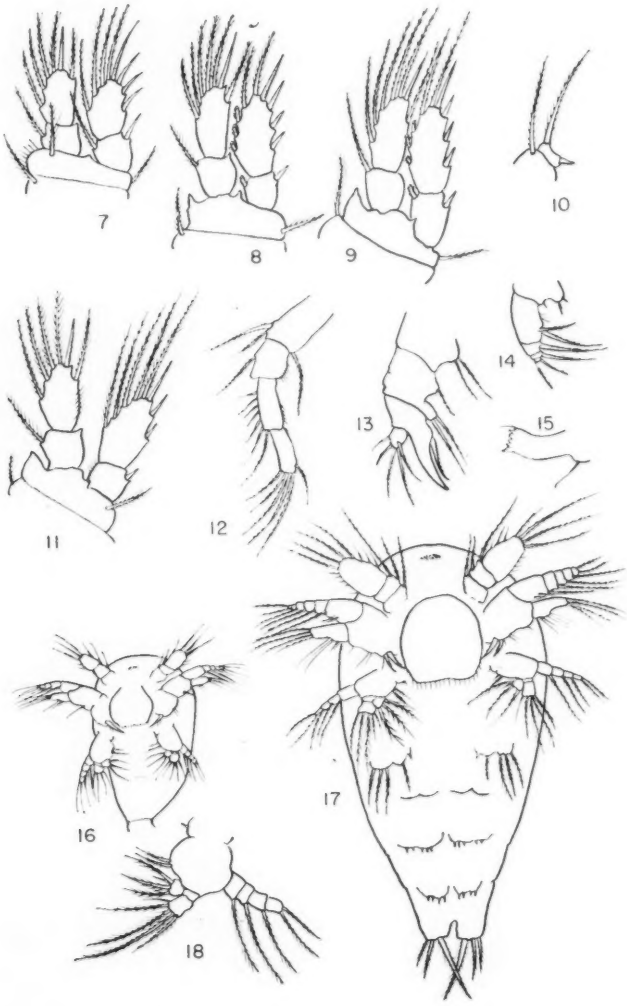
Female.—Body oval, broadest near middle of forebody. Its greatest depth about ¾ the width (Figs. 1, 2). Urosome (without caudal rami) about ½ the length of forebody; genital segment broadest at the anterior end. The caudal rami are about 4 to 5 times as long as broad and are longer than the combined abdominal segments back of the genital segment and about as long as the latter. The terminal caudal setae are about twice the length of the caudal rami and the inner of these setae is slightly the longer. The internal and external caudal setae are nearly equal in length. The outer one is inserted somewhat laterally. The lateral seta is inserted just posterior to the middle of the ramus. The first antennae are composed of eleven distinct segments and are only slightly shorter than the head segment (Fig. 3). The mouth appendages are shown in figures 13-15. The rami of the natatory legs are composed of two segments, the second basis of the first leg bears a long inner spine (Fig. 7). The distal endopod segment of the fourth leg has but one terminal spine (Fig. 11), and there are four inner setae on the segment as opposed to three shown by authors for closely related species. There is no inner seta on the first exopod segment of the fourth leg and the terminal segment has but two outer spines. The fifth legs consist each of one free segment and a broad basal segment confluent with the urosome segment (Fig. 10). The fused segment bears one long seta. The free segment is broad, appearing as a thick lamella and bears a long seta and a strong inner spine. This contrasts with the cone-shaped, slender, free segment found in this position in *C. bicolor* and *C. varicans*, and others.

Length including caudal rami: 0.85-1.08 mm., average 0.96 mm.; specimens deposited in U. S. National Museum No. 92743.

Male.—Body more slender and less oval than in female (Figs. 4, 5). Genital segment rounded and quite pronouncedly swollen. The anal segment is longer than either of the two preceding segments. The first antennae are twice geniculated (Fig. 6). The segmentation is not clear, but there appears to be about 14 segments. The end segment is shorter than the penultimate. The natatory legs are as in the female. The fifth legs are as in the female but the inner spine of the free segment is longer and more seta-like. The sixth legs are each represented by three well-developed setae.

Length including caudal rami: 0.72-0.78 mm., average 0.75 mm.; specimens deposited in U. S. National Museum No. 92743.

Nauplius.—The nauplius is characteristically cyclopoid especially with



Figs. 7-18. *Cyclops dimorphus*—7. Female-first leg; 8. Female-second leg; 9. Female-third leg; 10. Female-fifth leg; 11. Female-fourth leg; 12. Female-second antenna; 13. Female-first maxilliped; 14. Female-second maxilliped; 15. Female-mandibular blade; 16. Nauplius larva-ventral; 17. Nauplius larva last stage-ventral; 18. Nauplius larva, mandible.

respect to the mandibular structure (Figs. 16-18). In the last stage the body is oval with the greatest width anterior to the middle. There is no constriction at the posterior end as shown by Gurney (1933) for *C. gracilis* but the caudal armature is similar to that species in that each ramus has a strong apical seta flanked on the outside by a pair of shorter, lighter setae. This differs from the caudal structure of *C. bicolor* as given by Ewers (1930) and for *C. minutus* by Gurney (1933) where the apical setae are very weak.

Remarks.—The Salton Sea species is allied to *C. bicolor* but it differs from that species particularly in the structure of the fifth and sixth legs and in the absence of a small outer terminal spine on the distal endopod segment of the fourth leg. It differs also in the structural features from the closely related *C. rubellus* and *C. varicans* from which it differs also in the fewer number of segments in the first antenna and in the more slender caudal rami. There are some similarities also to *C. minutus* and *C. gracilis* but it differs from these species notably in the presence of a long inner spine on the second basis of the first leg, in the structure of the fifth legs, and in the structure of the nauplius larvae. It resembles *C. panamensis* Marsh in general form of the female fifth legs but it is distinct from that species especially by its more robust body and by the proportional lengths of the caudal rami and the abdominal segments. In *C. panamensis* the rami are somewhat shorter than the last two abdominal segments.

C. dimorphus is the only species of cyclopoid found in collections made on the following dates in the Salton Sea: Oct. 29, 1944—Desert Beach; May 13, 1945—Desert Beach; Jan. 5, 1946—Desert Beach; Dec. 30, 1946—Sea Plane Base, Westmorland; June 22, 1947—Desert Beach; April 29, 1949—Sea Plane Base, Westmorland; Dec. 28, 1949—Sea Plane Base, Westmorland.

It was especially abundant in the October 1944 collection when many females carried a pair of egg sacs each with 12 to 16 eggs. In the other collections it was common except for May 13, 1945 when it was rare.

The salinity of Salton Sea at the above dates and locations ranged from 27.81 to 28.40 parts per thousand.

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A Re-description of Typical Daphnia clathrata Forbes and Daphnia arcuata Forbes

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As difficult as a taxonomist's material may be, some of his most baffling and vexatious problems are created by the inadequate descriptions of his predecessors when their type specimens are not available. This became apparent to the author in the course of a classification of the species of *Daphnia* found in New England and adjacent regions. Most of the species based upon North American types were described by S. A. Forbes between 1882 and 1893. He described five species and two varieties—*retrocurva* 1882, *retrocurva* var. *intexta* 1891, *arcuata* 1893, *clathrata* 1893, *dentifera* 1893, *thorata* 1893, *pulex* (de Geer) 1778 var. *pulicaria* 1893. Forbes' descriptions usually lack information on structures critical to specific diagnosis today. The descriptions of *dentifera* and *pulex* var. *pulicaria* are the only ones supplemented by illustrations, and these figures, like the written descriptions, omit many important diagnostic structures. Nowhere in his writings has Forbes indicated where the types are preserved. *Daphnia retrocurva* with its large and distinctive helmet is the only one of his species to which specimens can be assigned with certainty. The other species, the troublesome ones, are all described in Forbes' 1893 paper entitled *A Preliminary Report on the Aquatic Invertebrate Fauna of the Yellowstone National Park, Wyoming, and the Flathead Region of Montana.* The United States National Museum, which seemed a likely depository, has no material collected on these two expeditions which were undertaken for the United States Commission of Fish and Fisheries (Chace, *in litt.*).

A partial, and completely unexpected, solution to these difficulties came during the examination of E. A. Birge's collection of mounted *Cladocera* which was generously loaned by the Natural History Museum of the University of Wisconsin. Among this collection there were several slides which give every appearance of bearing typical *Daphnia clathrata* and *Daphnia arcuata*. It is the aim of this contribution to describe these specimens and to re-define these two of Forbes' species.

It seems appropriate, however, first to consider the evidence from which it is concluded that the specimens are typical. There are five slides in all, two labeled *Daphnia arcuata*, three *Daphnia clathrata*. The method of mounting and the labeling on these slides differs from that of the remainder of the Birge collection. The two *arcuata* slides have paper labels at either end. All four labels were almost certainly written by the same hand at the same time. On each slide the specific name followed by *n. s.* is written on one label, and on the other "Heart L. Surface cloudy light breeze, 9 A.M. July 29, 1890." In the specific description Forbes (1893, p. 241, l. 42) gave "Heart Lake, Yellowstone Park, Wyoming" as the type locality. Furthermore, the date

agrees with the itinerary of the 1890 trip. "From Lewis Lake we rode to Heart Lake, a distance of 7 or 8 miles along the foot of the Red Mountains. Arriving at noon of the 26th,——" and "Our stay on this charming spot extended to nearly five days, all of which but one were spent in continuous collecting from the lake and from the tributary already mentioned as Witch Creek." (op. cit., p. 208, ll. 41-42; p. 209, ll. 9-11.) In a consideration of the investigation of Heart Lake Forbes further stated "Collections were made with the surface net from the open water at various hours of the day from 9 a.m. to 9 p.m., under such conditions of weather as offered themselves." (op. cit., p. 221, l. 16.) After mentioning that *Daphnia arcuata* had been taken in hauls along the margin, Forbes went on to say (p. 222) that an occasional *Daphnia* was taken in the open water tow-netting. Although the specific name is not included in this last statement, *arcuata* is the only species anywhere mentioned from Heart Lake. The three specimens on these two slides agree with the description of *arcuata* except for the pectination of the anal claw (see detailed comparison below). This discrepancy is due, with little doubt, to the different magnifications at which the claw was studied by Forbes and by the author. The agreement of the specimens with the description and the information on the label with that which Forbes published leads to the conclusion that these mounted specimens are typical *Daphnia arcuata*.

The handwriting of the locality labels on the *clathrata* slides strongly resembles that on the *arcuata* slides. The specific name followed by the name of the author is written on the left hand label of the three slides. The ink in these words is much darker than that on the right hand labels which give locality and date. Two of the slides are labeled "Grebe Lake," the type locality, while the third bears a specimen from Shoshone Lake. The two Grebe Lake slides bear identical labels reading "Grebe Lake near bottom 30 ft. sun wind 12 m. Aug. 22, 1890." Forbes designated the type locality as "Grebe Lake, Yellowstone Park." In the itinerary of the 1890 trip, under the month of August, Forbes wrote "We went thence to the Grand Cañon, collecting by the way from the Gibbon above Virginia Cascade, and from minor waters passed, and on the twenty-second made a trip to a lake nameless to the guides, but marked Grebe Lake by the geologists, and mapped as the source of the Gibbon." (op. cit., p. 210, 11. 29-30.) But in the discussion of Grebe Lake Forbes made this statement: "This shallow, muddy lake, connected with the head waters of Gibbon River, is so far secluded within the forest that it has no current name, and is locally almost unknown. We reached it August twenty-seventh, with saddle and pack animals, from the Grand Cañon Hotel, carrying canvas boats, seines and our smaller apparatus." (p. 234, 11. 32-35.) This second date is certainly in error. The only mention of the Grand Cañon in the itinerary is that previously quoted, just prior to the Grebe Lake trip. Furthermore, the itinerary states that the twenty-seventh was occupied with collecting at a place which is some distance away. The date of collection as given on the slide, therefore, coincides with that given for the collection of the type material. As the three specimens on these two slides fit the description of *clathrata*, with the exception of some criteria discernible only at high magnifications (see detailed comparison below) and the labels are consistent with Forbes' records, it is concluded that these three specimens, on the two slides

labeled "Grebe Lake," are typical *Daphnia clathrata.*

The specimen on the slide labeled "Shoshone Lake" is not considered typical, as this locality is nowhere designated by Forbes for *clathrata.* This does not mean, however, that the Shoshone Lake specimen may not be assignable to *clathrata.*

DAPHNIA CLATHRATA Forbes, 1893

DESCRIPTION OF TYPES

Lectoholotype (Fig. 1, A).—Mature ♀ with two disintegrating eggs in brood pouch. Length of head and carapace, 1.50 mm. Length of head (to posterior surface of antennule) = 380 microns; depth (at level of rostrum), 790 microns. Mounted on slide with left side uppermost. Fornices only structures distorted by compression. Left fornix has buckled immediately anterior to base of antenna, while right one is folded near its anterior end. Anterior antennal adductor muscle pulled away from its attachment. Shell spine broken. Artifacts indicated in figure by arrows.

Ventral margin of head barely sinuate, with a convexity at level of posterior margin of eye. Posterior to this the margin is slightly concave, then runs straight to well-developed rostrum. Posterior surface of rostral portion of head produced into median carina the greatest depth of which is clearly dorsal to tips of antennules, not extended between them. Edge of carina with 2-4 spinules. The continuation of the carina between the tips of the antennules distinctly lower than these tips, Fig. 1, D. Anterior end of head with crest (base of which is indicated by interrupted line on drawing). Margin smoothly rounded from vertex to a point dorsal to middle of attachment of anterior antennal adductor. Margin between this point and a point dorsal to middle of posterior adductor very slightly expanded. Rest of margin gently curving to junction with carapace. As anterior portion of dorsal margin of carapace is straight, there is a change in curvature but no emargination at junction of head shield and carapace. Anterior edge of fornix curves ventrally, ending dorsal to posterior lenses of eye. The ridge from which the fornix arises continues anteroventrally, lateral to the eye. Middle three-fourths of ventral edge of fornix nearly straight when viewed laterally. Posterior end curves dorsally to mandibular articulation. Both left and right fornices in this specimen folded due to compression, as previously noted. In lateral view the dorsal end of the head shield-carapace suture curves posteriorly, making an acute angle with dorsal margin of head.

Carapace in lateral view shaped like heart with one lobe missing. Anterior margin of carapace widely separated from posterior margin of head. Ventral margin more strongly curved than dorsal. Both margins smoothly curved. Dorsal margin spinulose from shortly behind junction with head to base of shell spine. Eighteen spinules in each series. Except for anteriormost 4-5 spinules, spinule length is as great as distance between spinules. Ventral margin spinulose from point ventral to juncture of head and dorsal margin of carapace. Twenty-seven spinules on each valve. Along anterior half of spinulose ventral margin spinules about ¾'s as long as inter-spinule distance. Spinules on postero-ventral margin as long as, or longer than, distance between spinules.

End of shell spine broken off, leaving basal portion 545 microns long. Spinules from dorsal and ventral margins of valves continuous on to shell spine. Shell spine bears prominent mid-lateral carina. Carina broad at base of shell spine, merging anteriorly into broader, lower ridge. Carina becomes progressively thinner and lower as it extends posteriorly. Extent of carina (excluding anterior ridge) indicated in drawing.

Dorsal margin of postabdomen nearly straight, Fig. 1, B. Abdominal processes collapsed and obscure.

Anal teeth—10 on left side, 12 on right (see figure).

Anal claw with pectination in three fields, Fig. 1, C. Proximal comb with seven teeth, the longest of which is one-third as long as the longest tooth of middle comb. Middle comb with five teeth, distal three of which are curved, of nearly same length. Diameter at base greatest in most distal tooth, decreasing progressively in next two. Fourth tooth (counting from distal to proximal) is straight, two-thirds as long as third tooth, and of smaller basal diameter. The fifth tooth is intermediate in size and position between the four distal members of the middle comb and those of the proximal comb. It is here considered part of the middle comb. The size, position and approximate number of fine teeth in the distal comb are indicated in the drawing.

Optic vesicle (within which the compound eye is situated) extends to antero-ventral margin of head. Ventral end of cephalic crest immediately anterior to middle of compound eye. Length of lens emergent from pigment equal to diameter of lens. Diameter of lenses, 28-40 microns. Least diameter of compound eye, including lenses, 145 microns; greatest, 180.

Tips of swimming hairs of antennae extend to concavity at posterior end of ventral margin of valve. Antennae (without swimming hairs) are three-fourths the length of the carapace. Ventral margin of mandible continued anteriorly into distinct conical projection. Left mandible in lateral view is figured at low magnification.

Lectoparatype A.—Mature ♀ with four embryos in brood pouch. Length of head and carapace, 1.45 mm. Length of head, 390 microns; depth, 780 microns. Mounted on slide with right side uppermost. Anterior adductor muscle pulled away from attachment. Shell spine broken.

Ventral margin of head slightly more sinuate than in lectoholotype, but in same sense. Carina on posterior surface of head dorsal to tips of antennules, even deeper than in specimen figured (lectoholotype). Edge similarly spinulate, central two spinules relatively more prominent than those in figure. Anterior and dorsal margin of head as in lectoholotype. In addition the margin midway between attachment of anterior and posterior adductor muscles slightly thickened. This is undoubtedly the site of spine present in younger instars. Also, a distinct emargination in dorsal margin above middle of posterior half of antennal levator muscle attachment. A small disc-shaped structure forms the bottom of this emargination.

Shape of carapace as in lectoholotype. Dorsal margin with 17-18 spinules in each series. Length of each spinule equal to three-fourths of distance between spinules. Ventral margin of right valve with 30 spinules, left with 23. Length of spinules as in lectoholotype. Shell spine (tip broken off), 460 microns in length.

Postabdomen obscured by overlying structures.

Least diameter of compound eye including lenses, 160 microns; greatest, 210. Diameter of lenses of compound eye, 25-40 microns.

Antennal length as in lectoholotype. Conical projection on external surface of mandible near anterior end of distal edge present but not as prominently displayed as in lectoholotype.

Lectoparatype B (Fig. 1, E).—Immature female, mounted on slide with lectoparatype A, left side uppermost. Anterior antennal adductor muscle pulled away from attachment. Terminal portion of shell spine broken off. Length of head and carapace (excluding shell spine), 1.05 mm. Depth of head (at level of rostrum) = 600 microns. Artifacts indicated by arrows in figure.

Ventral margin of head nearly straight; the sinuosity indicated in figure is slightly exaggerated to call attention to its presence. Crest along antero-dorsal margin of head well-developed posteriorly as far back as middle of attachment of posterior antennal adductor, and extending to the apex of head shield. Crest bears angle with emarginate anterior edge between anterior antennal adductor and levator. Rostrum shorter than sensory hairs. Median carina on posterior margin of head well developed.

Dorsal margin of carapace straight or slightly concave. Ventral margin tapers toward base of shell spine from point opposite junction of head shield and carapace on dorsal margin. Shell spine with lateral carina.

Posterior margin of postabdomen nearly straight as in figure of lectoholotype. Nine anal teeth on each side. Pectination on claw, although obscured by overlying structures, apparently agrees with that of type figured, except that distal tooth of middle field appears longer than others. Dorsal abdominal processes not visible.

Antenna, to tip of ventral ramus, and to end of swimming hairs of same relative length as in other types.

**Lectoparatype* C.—Immature female lying flat on left side. Stained (borax-carmine ?). Tissue of head shrunk away from cuticule.

Dimensions: CL—0.69 mm., CW—0.45 mm., HL—0.26 mm., HW—0.475 mm., SS—0.44 mm., Antenna (to end of ventral ramus)—0.45 mm., Antenna (to tip of swimming hairs)—0.675 mm.

Head: Head deeper than carapace. Angulate crest even more developed than in lectoparatype B, so that if line of dorsal margin of carapace is continued forward as far as the anterior-most extension of head this point marks the apex of the cephalic angle.

Fornix does not reach annuli at base of antenna. Free edge strongly concave opposite base of antenna. Anterior end of fornix dorsal to midpoint between posterior edge of eye and anterior face of antennal base. The ridge into which it merges continues forward as far as line in Fig. 1, E.

Carapace: Carapace of same shape as in lectoparatype B. Spinules on dorsal margin extend even farther forward than in lectoparatype B. Ten

* Subsequent to the re-description of the previous specimens, more of Forbes' material has been made available through the generosity of Prof's. H. J. Van Cleave and Samuel Eddy. One slide labeled "Tow Grebe Lake, Aug. 22, 1890" bore a small *D. clathrata*.

spinules in single series. Spinules on ventral edge of valves also extend farther forward, with 22 on edge of each.

Shell spine set at same angle as in lectoparatype B (Fig. 1, E).

Abdomen: Anal ridges curved as in lectoholotype with 8 teeth on right, 9 on left.

Pectination of postabdominal claw as in lectoholotype.

COMPARISON OF LECTOTYPES WITH ORIGINAL DESCRIPTION*

SIZE

1. Forbes gives length of ovigerous female as 1.7 mm. to base of the shell spine.

Lengths of the two ovigerous females, lectoholotype and lectoparatype A, to the inflection point on postero-ventral margin of valve (cf. Brooks, 1947) are 1.5 and 1.45 mm., respectively. To base of spine, the lengths are 1.6 and 1.55 mm.

2. The greatest depths of the ovigerous females are 0.865 and 0.83 which agree with the value of 0.85 which Forbes gives.

HEAD

1. "In adult female the head, measured vertically across the rostrum, is twice as deep as its length from the base of the antenna to the middle of the front."

$$\text{Holo.}-\frac{\text{Head depth}}{\text{Head length}}=\frac{0.79\text{ mm.}}{0.38\text{ mm.}}=2.08$$

$$\text{Para. A.}-\frac{D}{L}=\frac{0.78\text{ mm.}}{0.39\text{ mm.}}=2.0$$

$$\text{Para. B. (immature)}-\frac{D}{L}=\frac{0.60\text{ mm.}}{0.30\text{ mm.}}=2.0$$

NOTE: The posterior surface of the antennule near its base is taken to mark the posterior border of the head, rather than the base of the antenna.

2. "It is sharply keeled rather than crested, very broadly rounded, its lower margin very slightly convex or quite straight, and its rostrum well marked in the adult. In the immature female there is a prominent angle just above the swimming antennae, like that of *D. dentifera*."

The principal difference in the size of crest (or keel) between immature and mature specimens is along the dorsal surface of head. Anterior extent of crest relatively constant (ratio, head length to depth, nearly constant). The ventral margin of head while nearly straight is neither completely straight nor slightly convex; it is sinuate. Cephalic spine or angle in lectoparatype B is comparable with that in *D. dentifera* which Forbes figured (1893, Fig. 2).

3. "The fornices are not prominent. Beginning midway between the antenna and the eye, they arch broadly above the base of the former, making an obtuse angle a little beyond the antenna, and continuing as a slight carina backwards and downwards for a little distance on the side of the valves."

In all specimens the ridge from which the fornix projects continues antero-

* All of the original description is quoted, although the order of the sentences has been altered.

ventrally passing lateral to the anterior half of the compound eye. The anterior end of the fornix is nearer to the eye than Forbes indicates. It is not clear what Forbes meant in the last phrase in the above quotation. No carina is visible in any of the specimens. The only structure to which he could have been referring is the suture between the head shield and the carapace. Forbes also mentions a posterior continuation of the fornix in his descriptions of *D. arcuata* and in *D. pulex* var. *pulicaria* in contexts which make it clear that he is concerned with the suture of head shield and carapace. In none of the three species is there any indication of a shell fornix such as that of *D. atkinsoni* (cf. Wagler, 1936).

4. "The pigment speck is very minute, placed behind the lower half of the eye, and nearer the posterior margin of the head."

The difficulty, if not the impossibility, of demonstrating an ocellus in any of the specimens at hand can in all probability be attributed to the loss of its pigment subsequent to the preservation and mounting of the specimens.

5. "The antennae are rather short, about half as long as the distance from the posterior margin of the eye to the base of the posterior spine." This relation is correct. However, it seems preferable to relate antennal length to carapace length. In all three specimens this ratio is about 0.75.

6. "The swimming hairs are two-jointed, the basal joint the shorter." The two joints are of very nearly equal length.

CARAPACE

1. "The ventral margin of the shell is more broadly arched than the dorsal, the latter being in the immature female, nearly straight from the heart backwards."

The slight deviation from straightness in the dorsal margin of the immature female is in the direction of concavity.

2. "The valves are conspicuously quadrangular reticulate, spinose on their lower edges nearly to the beak, and on the upper edge to the vicinity of the heart."

Neither the presence of quadrangulate reticulation of the carapace nor the size of the reticules is of taxonomic value. As each reticule apparently covers the external surface of one hypodermal cell, the size of the reticules will change at each molt.

The spines on neither dorsal nor ventral margins of the specimens extend as far anteriorly as is implied by Forbes' statement.

3. "The posterior spine is very long, straight, slender, spinose to the tip, contained in average cases not more than twice in the length of head and body without the spine."

If the shell spine in the adult is about half the length of the head and carapace, then the broken spine on the lectoholotype, figured, is about three-quarters of the full length.

ABDOMEN

1. "The dorsal abdominal processes arise in immediate connection, but are not united at their base."

Dorsal abdominal processes not distinguishable in available types.

2. "The anal furrow has about a dozen teeth on each side, and the caudal

claw has a comb of three or four conspicuous teeth at its base, besides a little group of smaller ones."

In the lectoholotype there are 10 anal teeth on one side and 12 on the other. In the immature specimen there are 9 on each side.

The "comb of three or four conspicuous teeth" at the base of the post-abdominal claw is undoubtedly the middle comb of five teeth. The smallest, most proximal, tooth of the five is difficult to see except at high magnifications (x 970) and could easily have been overlooked. The "little group of smaller ones" is undoubtedly the proximal comb with its seven teeth, the longest of which is about one third that of the longest tooth of the middle comb.

DIAGNOSIS OF DAPHNIA CLATHRATA FORBES*

Length of ovigerous female along body axis to level of concavity on postero-ventral margin of values, 1.45-1.5 mm. Greatest depth (at right angles to body axis), 0.83 to 0.87 mm. Length of head, measured to posterior surface of antennules, one-half depth of head at level of rostrum. Carapace 1 mm. long. Shell spine about three-fourths length of carapace. Antenna, to tip of ventral ramus, three-fourths as long as carapace. When antennae are folded against carapace, the tips of the swimming hairs reach the level of the concavity on the postero-ventral margin of the valves.

Ventral margin of head from vertex to rostrum slightly sinuate. Shortly behind line of contact of optic vesicle with margin there is a slight convexity, followed by a shallow concavity. From the posterior side of concavity margin continues straight to tip of rostrum. Rostrum about the length of the sensory hairs.

The greatest depth of the median carina on posterior surface of head is dorsal to tips of antennules. Carina moderately deep with several (2-4) small spines along its edge. Continuation of carina between tips of antennules distinctly lower than tips. Dorsal end of carina as seen in lateral view distinctly raised from posterior surface of antennules.

Head with crest extending from a point anterior to middle of compound eye to the anterior end of the attachment of the posterior antennal adductor. Crest continues into low keel which extends to apex of head shield. Margin of crest in adult smoothly rounded from vertex to point opposite middle of insertion of anterior antennal adductor. Margin very slightly expanded between this point and mid-point of posterior adductor attachment. Rest of margin curving slightly dorsally then ventrally to the apex of the head shield.

Anterior end of fornix at, or slightly posterior to, level of posterior lenses of compound eye, and slightly dorsal to level of dorsal lenses of compound eye. Ridge from which fornix arises continues antero-ventrally, passing lateral to anterior half of compound eye. Free edge of fornix straight in lateral view, not expanded at posterior end. Suture of head shield and carapace sigmoid in lateral view.

Optic vesicle (containing compound eye) touches margin. Least diameter of compound eye, including lenses, 145-160 microns; greatest, 180-210. The length of lens emergent from the pigment is about equal to the transverse

* Based upon the three lectotypes and the original description by Forbes.

diameter of lens. This diameter varies between 25 and 40 microns.

Of the ocellus, which is not visible in any of the specimens at hand, Forbes stated, "The pigment speck is very minute, placed behind the lower [ventral] half of the eye and nearer the posterior margin of the head."

Seven or eight sensory hairs project from the tip of each antennule. These hairs are about 60 microns in length.

Distal surface of mandible with conical projection from outer face of anterior end. In lateral view carapace of adult is shaped like a heart with one lobe deeply cut away. The free anterior edge of valve is widely separated from antennules and rostrum. Concavity of postero-ventral margin of valve not strongly marked. If the edge of the valve from a point opposite the rostrum to the base of the shell spine be divided into four sections of equal length, the posterior three sections will have a spinulose margin with a total of 23-30 spinules. Spinules along anterior half of spinulose margin slightly shorter than distance between spinules. Along posterior half spinules equal to, or longer than, interspinule distance.

Dorsal margin spinulose except for anterior one-eighth of its length, with 17-18 spinules in each row. Spinules from three-fourths as long, to as long, as interspinule distance.

Shell spine "is very long, straight, slender, spinose to tip" (Forbes). Shell spine bears a carina on each lateral surface which arises in a small ridge at base of spine, extends two-thirds of the length of the spine, decreasing in height and width distally.

"Dorsal abdominal processes arise in immediate connection, but are not united at base" (Forbes). Dorsal margin of post-abdomen nearly straight, with 10-12 anal teeth.

Postabdominal claw with pectination in three fields. Proximal comb with seven teeth, longest of which is one-third as long as longest tooth of middle comb. Middle comb with five teeth, distal three of which are curved, of nearly the same length. Diameter at base greatest in most distal tooth, decreasing progressively in next two. Fourth tooth (counting from distal to proximal) is straight, two-thirds as long as third tooth, and of smaller basal diameter. The fifth tooth is intermediate in size and position between the four distal members of the middle comb and the proximal comb. It is here considered part of the middle comb although it may equally well belong to the proximal one. The size, position and approximate number of fine teeth in the distal comb are indicated in the drawing. The proximal teeth of distal comb are about as long as teeth of proximal comb.

The immature female differs from the adult chiefly in that:

1. The cephalic crest is relatively larger and is produced into an angle between the insertions of the antennal adductors.
2. Rostrum is shorter relative to length of sensory hairs.
3. The dorsal margin of carapace is straight, even slightly concave, with only about 11 spinules in each row.
4. Nine anal teeth on each side.

Male unknown.

Type locality: Grebe Lake, Yellowstone Park, Wyoming (Forbes, 1893).
Remarks on slide labels: August 22, 1890. 12 M. Sun, wind, Near bottom, 30 ft.

Grebe Lake is at the head of Gibbon River, in the north central part of Yellowstone. Gibbon River is a tributary of the Madison River, which flows west out of the park, then north to join the Missouri.

The lake is described as shallow—maximum depth of 36′—and muddy. The collecting sites in this oval lake with weedy margins were limited. "Our collections were made with a surface net in deep and shallow water, with a dredge at a depth of 36 feet (the greatest found), and with a hand net from grass and lily pads near the margin, from the gravelly bottom in shallow water and from the weedy mud—this list exhausting, in fact, all the varieties of situations offered" (p. 235). The indication on the slide labels that the specimens came from 30 ft., makes it likely that they were taken in a deep tow-netting. Forbes' only comment on the occurrence of this species is "here also we found *Daphnia clathrata* n.s., the only locality thus far discovered for it. It was not abundant in Grebe Lake and may have bred primarily in the swamps adjoining" (p. 235).

DAPHNIA ARCUATA Forbes, 1893

DESCRIPTION OF TYPES

Lectoholotype (Fig. 1, G).—Mature ♀ with two embryos in brood pouch. Length of head and carapace = 1.5 mm. Mounted on slide, right side uppermost with dorsal margin slightly higher than ventral. The coverslip is unsupported and the specimen has been considerably flattened. The ventral edges of the valves are appressed, that of the left (underneath) valve, which is indicated by a pecked line in the figure, is forced against the cover-glass. This flattening has produced two large folds in the right valve. The right fornix has been flattened over the base of the antenna. The pigment of both compound eye and ocellus has been decolorized. The shell spine is broken off at its base. The artifacts apparent in the figure are indicated by arrows.

Ventral margin of head with a well-marked concavity immediately posterior to level of eye. Rostrum elongate posteriorly well beyond anterior margin of carapace. Note: The relative extension of the rostrum may be exaggerated in this specimen by distortion of the carapace. Length of head (to posterior surface of antennule near its base) = 480 microns. Depth of head (at level of rostrum) = 760 microns. Head expanded anteriorly to form a helmet with a smoothly rounded margin.

Dorsal margin of head sinuate with a concavity dorsal to attachment of anterior antennal adductor followed by a convexity between this and the posterior adductor. Slight emargination on dorsal margin at junction of head and carapace. Anterior end of fornix dorsal to middle of compound eye. Right fornix flattened over base of antenna (see above). Posterior extent of right fornix obscured by folding.

Length of carapace (to concavity on postero-ventral margin), 1150 microns. Greatest depth = 890 microns. Posterior margin of carapace nearly straight (slightly convex) from junction with head posteriorly for one-half its length, then curves abruptly, and continues a nearly straight (slightly concave) course to the base of the tail spine. Spinulation extends from tail spine anteriorly almost to junction with head. Anterior four-fifths of ventral margin of valves subparallel to anterior half of posterior margin. Posterior fifth curves abrupt-

ly, running concavely to base of tail spine. Spinulation on ventral edge of valves extends along posterior half of ventral margin (as measured from opposite rostrum to tail spine).

Abdominal processes not distinguishable. Anal spines long and slender: on right side, 12 plus small double spines, on left, 10. Well-marked bay on dorsal surface of postabdomen (cf. Fig. 1, H.).

Postabdominal claw with usual three fields of pectination.

Details of tooth structure and arrangement obscured by overlying appendages and debris on right side. As best as can be determined from both right and left sides (at x 250), the pectination corresponds in size and number with that of lectoparatype A which is figured.

Ventral edge of the optic vesicle, containing the compound eye, well back from ventral margin of head. Pigment of compound eye appears somewhat decolorized in comparison with eye of lectoparatype A. Transverse diameter of lenses 17 to 22 microns. Greatest diameter through eye (including lenses), 121 microns; least, 104 microns. Ocellus not visible. Right antennule obscured by overlying structures. Rostral portion of head, viewed from left side at x 250 has a small terminal mound on antennule, with sense hairs not visible. Median carina on posterior side of head, dorsal to apices of antennules, low, lower than antennule mound. Antennal length (to tip of ventral ramus) just under three-fourths (71%) of length of carapace. Swimming hairs of antennae two-jointed, both joints of equal length. Tips of swimming hairs extend posteriorly as far as concavity on postero-ventral margin of valve when antennae are folded against body.

Lectoparatype A.—Mature ♀ with three eggs in brood pouch. Length of head and carapace, 1.87 mm. Tail spine (broken) = 450 microns.

Mounted on left side apparently in medium of different refractive index from lectoholotype.

Specimen flattened with many folds in head and carapace. Antennal muscles pulled away from insertions. Depth of head at level of rostrum, 865 microns. Length of head (to posterior surface of antennules) = 520 microns. Greatest depth of carapace = 1.05 microns. External structure of head and carapace as in lectoholotype. Tip of rostrum extends to, but not beyond anterior margin of carapace. Tail spine armed with small spines. Abdominal processes obscure. Postabdomen with bay in dorsal surface anterior to anal spines. Ten anal spines plus small double spine at anterior end of right series. Eleven spines in left side. Right postabdominal claw drawn, Fig. 1, F. Pectination in three fields. Proximal comb of five teeth, of which the middle one is longest, slightly longer than most proximal tooth of middle comb and about one-half the length of the most distal. Middle comb of four teeth, which become progressively longer and stouter toward distal end of comb. Distal comb of numerous fine teeth, number and size of which are approximately as drawn. Compound eye with pigment unmodified. Greatest diameter (including lenses) = 147 microns; least, 104 microns. Transverse diameter of lenses, 20-30 microns. Ocellus posterior to ventral half of eye, slightly less than half the distance from the posterior edge of eye to posterior

margin of head. Rostral region of head disotrted. Antennae as in lectoholotype.

Lectoparatype B.—Immature ♀. On slide with lectoparatype A. Length of head and carapace ca. 1.15 mm. Specimen lying on right side, flattened. Carapace much distorted. Depth of head at level of rostrum = 562 microns. Length (to posterior surface of antennules) = 475 microns. External structure of head as given for lectoholotype. Tip of rostrum extends well beyond anterior margin of carapace.

Spinulation on ventral edge of valves extends along posterior half. Spinulation of dorsal margin as in lectoholotype.

Postabdomen distorted; no bay apparent on dorsal surface. Eight anal spines plus rudimentary ninth on each side.

Left claw with pectination as in lectoparatype A. Right claw with 5 teeth in middle comb.

Greatest diameter of compound eye (including lenses) = 95 microns; least = 79. Ocellus not apparent.

Rostral region of head distorted.

COMPARISON OF LECTOTYPES WITH ORIGINAL DESCRIPTION*

SIZE

1. "Length 2 millimeters, depth 1 millimeter." Length of lectoholotype to base of shell spine (as Forbes measured body length) is 1.70 mm. and the greatest depth is 0.89 mm. Length, similarly, of lectoparatype A is 1.96 mm.; greatest depth, 1.05 mm.

HEAD

1. "Head helmetted, rounded in front, length one third that of shell, front concave, beak produced, extending beyond the sensory hairs of the antennae." Head length (to posterior surface of antennule) is 480 microns, carapace length (to postero-ventral concavity) is 1150 microns. Head length/carapace length = 0.42. However, as Forbes measured head (to anterior face of antennal base) and carapace (to base of tail spine) ratio is just under one third.

As sensory hairs of antennules are invisible, their length cannot be compared with that of rostrum. The lectoholotype corresponds with the original description in other features mentioned.

2. "The latter [posterior margin of head] concave, the beak extending backward and applied against margin of shell." In lectoparatype A the tip of the rostrum reaches anterior margin of carapace. The backward extension of the rostrum in the lectoholotype and in lectoparatype B may be exaggerted by distortion.

3. "Fornices beginning above the eye and extending nearly to the middle of the back, not expecially produced above antennae."

As noted in the description of *D. clathrata,* Forbes apparently considered the suture between head shield and carapace to be a continuation of the fornix. In the lectoholotype a fold in the cuticle runs along the suture line and may

* All of original description is quoted, although order of sentences has been altered.

represent a ridge developed along the suture line. It is by no means certain, however, that there is a ridge over the suture in the living animal. In the first place, this fold is continuous with two other folds on the carapace where there unquestionably were no antecedent ridges. In the second place, Forbes had described a similar structure in *Daphnia clathrata* where it is reasonably certain that no ridge existed.

4. "Swimming antennae reaching the middle of the shell, their hairs moderately robust, the first segment not longer than the second."

Specimens agree with description.

5. "Eye small, about midway between the mandibles and the front of the head, and about midway between tip of the beak and the dorsal surface of the head."

The small size of the eye is evident on comparison with *D. clathrata*. The greatest diameter in the lectotypes of *arcuata* is 147-121 microns; the least, 104. In the two ovigerous females of *clathrata*, the greatest diameter is 210-180 and the least is 145-160 microns.

The position of the eye in the head of a *Daphnia* is difficult to describe. In *arcuata* it can certainly be placed "midway between the mandibles and the front of the head." It is also near the midpoint of a line running obliquely from the tip of the rostrum to the antero-dorsal margin of the head.

6. "Pigment speck very small, less than half the diameter of a lens of the eye, and placed midway between the eye and the posterior margin of the head."

Ocellus not visible in lectoholotype, apparently due to decoloration subsequent to preservation and mounting. In lectoparatype A the ocellus is slightly less than half way from posterior surface of eye to posterior margin of antennules, and of the size indicated.

7. "No emargination separating head from body, but the dorsal surface very slightly sinuate there."

Although this description is not particularly apt, it is not inconsistent with the appearance of the lectoholotype. The dorsal margin of the head curves ventrally as it meets the straight margin of the carapace.

CARAPACE

1. "Shell moderately coarsely marked in quadrangular areas, the lower and dorsal margins spinulose from the middle backwards."

If the ventral or "lower" margin of the valves is taken as beginning at a point opposite the rostrum and extending to the base of the shell spine, the spinulation is limited to the posterior half of this margin. On the dorsal margin the spinules extend from the base of the shell spine almost to the junction with the head shield. Considering the entire dorsal margin, from base of shell spine to middle of helmet, the spinulation can be said to extend along the posterior half. Possibly Forbes had this in mind.

2. "Posterior spine of shell given off from the middle of the valves, in the adult female a third to a half as long as the valve."

This aptly describes position of shell spine. The length of the remnant of the shell spine in lectoparatype A is one-third the length of the carapace.

ABDOMEN

1. "Anal spines about ten."

In the lectoholotype there are 10 anal teeth on one side, 12 on the other. In lectoparatype A there are 10 on one side, 11 on the other.

2. "Abdominal processes all distinct, anterior much the largest."

These processes obscure in all specimens at hand.

3. "Caudal claw with accessory teeth about six in number, the three proximal the largest."

This description is impossible to reconcile with the appearance of the specimens. The teeth of the middle and proximal combs might, at a low magnification be considered "about six in number" because the proximal comb would be obscure. In either case the three large teeth of the lectotypes would be distal, not proximal. It is also possible that Forbes saw only the middle comb which may have 5 teeth although 4 is more usual in the available specimens.

DIAGNOSIS OF DAPHNIA ARCUATA FORBES*

Length of ovigerous female, along body axis, to concavity on postero-ventral margin of valves, 1.5 to 1.85 mm. Length of head is about 500 microns. Head length 60-65% of depth of head at level of rostrum in type specimens.**

Carapace of ovigerous females, 1.15 to 1.3 mm. long; greatest depth, 0.89 to 1.05 mm. Shell spine one-third to one-half the length of the carapace (Forbes). Length of antenna—to tip of ventral ramus—just under three-fourths (71%) of carapace length. When the antenna is lying along body axis the tips of the swimming hairs extend to concavity on postero-ventral margin of valves. Swimming hairs with two joints of nearly equal length.

Ventral margin of head with distinct concavity at level of posterior lenses of eye. Posterior to this the margin is expanded, then curves dorsally near the tip of rostrum. Tip of rostrum extends to, or beyond, anterior margin of carapace. In the type figured the carapace may have been pushed forward.* Carina on posterior surface of head low, less deep than exserted portion of antennules. Extent of helmet on anterior end of head can be judged by distance of antennal adductor attachment and optic vesicle from margin. Margin of head is smoothly rounded from concavity below eye to a point opposite the attachment of the anterior antennal adductor. The margin is sinuate between this point and the apex of the head shield. It is expanded between the insertions of the anterior and posterior antennal adductor and over that of the levator.

Anterior end of fornix dorsal to middle of compound eye. Fornix probably with slight expansion at posterior end when viewed laterally.** In lateral view the suture between head shield and carapace is nearly straight as it approaches dorsal margin.

Optic vesicle (containing compound eye) well removed from margin. Compound eye small. The greatest diameter (including lenses), 120-150

* Based upon lectoholotype, lectoparatype A and original description.

** The size and shape of the head are probably seasonally variable. The type collection was made near the end of August, and probably the specimens approach the maximum helmet development.

microns, while the least is about 105. Transverse diameter of lenses, 20-30 microns.

The ocellus is "very small, less than half the diameter of a lens of the eye" (Forbes), just less than half way from the posterior lenses of eye to the posterior surface of the antennules.

Anterior half of dorsal margin subparallel to anterior four-fifths of ventral margin of carapace. Remainder of each margin curves sharply to base of shell spine. Dorsal margin spinulose nearly to junction with head shield. Spinules relatively short, with 20-30 spinules in each series. They attain their greatest length just anterior to the curve in margin. Here they are about ½ the interspinule distance. The spinules nearer the shell spine are shorter and farther apart.

Ventral margin of carapace spinulose along posterior half, if ventral margin is measured from a point opposite the rostrum to base of spine. About thirty spinules on margin of each valve, all of nearly equal length. Interspinule distance at anterior end of series 3-4 times spinule length, decreasing gradually to the equal of the spinule length at the base of the shell spine.

Shell spine on midline between sub-parallel margins of carapace. Forbes gives its length as a third to a half of carapace length.

"Abdominal processes all distinct, anterior much the largest" (Forbes).

Dorsal margin of postabdomen sinuate. Anal teeth borne on convex margin which dips in anterior to the the smallest teeth, forming a distinct bay.

Anal teeth 10-12 in number.

Pectination of postabdominal claw in three fields. The proximal comb consists of about five teeth of which the central one is the longest, being about half the length of the longest of the middle comb. The middle comb usually with four, sometimes five, large teeth which become progressively stouter an ' longer toward the distal end of the comb. The fine teeth of the long distal comb are of the size and approximately of the number indicated in the figure. The longest teeth in the distal comb are distinctly shorter (about half) than those of the proximal comb.

Male unknown.

Type locality: Heart Lake, Yellowstone National Park, Wyoming.

Remarks on slide labels: July 29, 1890, 9 a.m. Surface; cloudy; light breeze.

Three lakes, Heart, Shoshone and Lewis, in the southern part of Yellowstone Park are south of the continental divide and drain into the Snake River. The Snake eventually empties into the Pacific via the Columbia. According to Forbes' collections, however, Shoshone and Lewis Lakes differ from Heart Lake in their *Daphnia*. He reported *D. pulex* from Shoshone Lake and a new species, *dentifera*, as well as *pulex* in a pond near its shore. *D. dentifera* occurred in great quantity in Lewis Lake also. The species which Forbes has named *arcuata* was taken in Heart Lake and in no other place. Heart Lake

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* Size of rostrum may be seasonally variable.

** Compression of the fornices in the available specimens has distorted these structures to an unknown extent. Their natural appearance can only be surmised. It must be remembered that the fornix in the specimen illustrated has been flattened over the base of the antenna.

is described as very clear, at least 45 m. deep and weedy at the margin (p. 221). Forbes mentions (p. 222) *Daphnia arcuata* in his list of invertebrates collected in "various alongshore hauls, at or near the bottom and through the weeds." In tow-netting in open water "an occasional *Daphnia*" was found. As noted early in this paper the mounted types were apparently taken in these surface tow-nettings.

PRESENT TAXONOMIC STATUS OF FORBES' SPECIES

Since the time when Forbes' descriptions were made, there has been a tendency to consider all North American populations of *Daphnia* as varieties of common European species. This has reached its acme in the recent classification of North American *Daphnia* proposed by Kiser (1950). Using his scheme, the type specimen of Forbes' *retrocurva*, for example, must be designated *Daphnia pulex* (de Geer) *parapulex* Woltereck *retrocurva* (Forbes). I find this system not only clumsy but unjustifiable. In my opinion *retrocurva* is one of several or many species of North American *Daphnia* which are distinct from European species. Descriptions of other such species occurring in North America are being prepared. When material from all of North America has been examined, Forbes' species should find their places in a natural classification.

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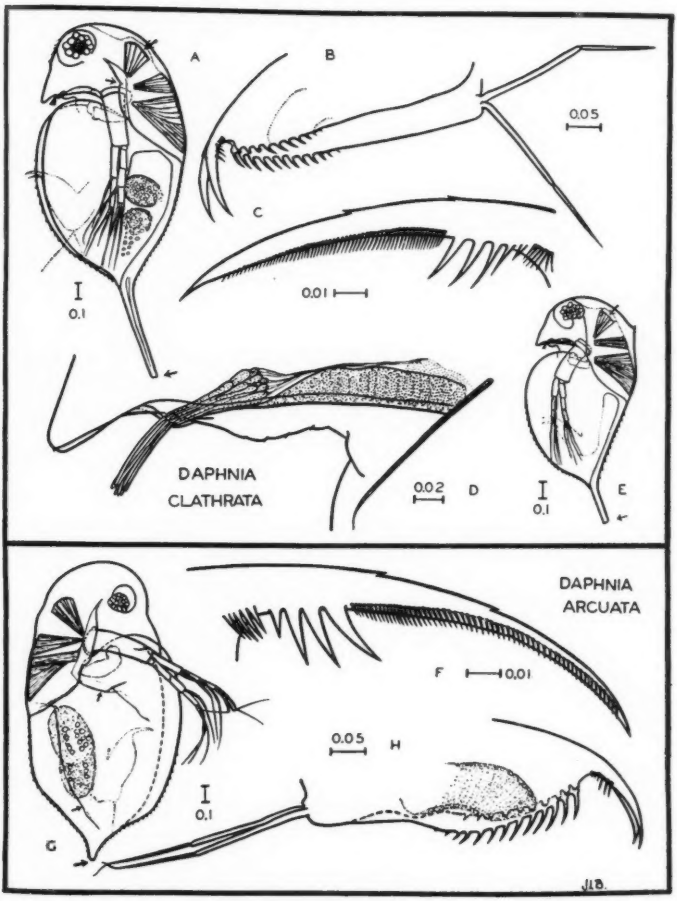

Fig. 1.—*Daphnia clathrata:* A. Lectoholotype; B. Same, post-abdomen; C. Same, left postabdominal claw, lateral aspect; D. Same, rostral portion of head; E. Lectoparatype B (immature). *Daphnia arcuata:* F. Lectoparatype A, right postabdominal claw, lateral aspect; G. Lectoholotype; H. Lectoholotype, postabdomen.
Drawn with aid of camera lucida. Scale in millimeters. Arrows indicate artifacts.

A New Conchostracan Phyllopod, Eulimnadia alineata, from Arkansas*

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Early in 1949, Dr. Fenner A. Chace, Jr., Curator of Marine Invertebrates, U. S. National Msueum, sent nine specimens of a phyllopod crustacean to the writer for identification. These specimens had been collected during August, 1948 in rice fields near Stuttgart, Arkansas by Prof. F. E. Whitehead of the University of Arkansas. Upon preliminary examination the animals were seen to belong to the conchostracan genus *Eulimnadia* and seemed to represent an undescribed species. However, the single male, essential in diagnosis of species in the genus, was immature thus making positive identification uncertain. A subsequent collection on June 30, 1949, from the same locality, by the same collector, contained mature males thus making possible a more certain evaluation of the animals. It has been determined that these are quite distinctive and represent a new species of the genus. The name, *Eulimnadia alineata*, is here proposed for this species.

Eulimnadia alineata n. sp.

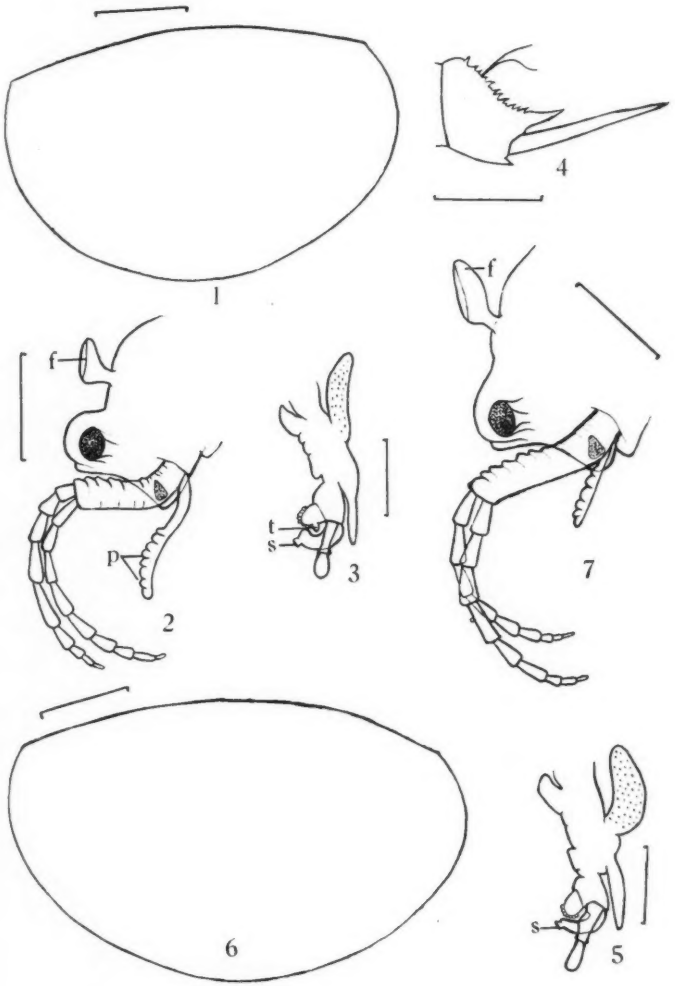
Male: With the characteristics of the genus (Packard, 1883, Daday de Dees, 1926). The bivalve shell (fig. 1) is transparent and oval. The dorsal hinge margin is only slightly convex, the ventral margin much rounded. The average length of the shell is 4.2 mm. and the greatest height near the middle of the shell, 2.65 mm.

The chief diagnostic feature of this species, unique for the genus, is the absence of lines of growth on the shell.

The head possesses the prominent "frontal organ" typical of the genus (fig. 2). This frontal organ is of an irregular, inverted bell shape, extending posteriorly from its attachment. The front is slightly concave with a rounded ventral margin. The scape of the second antenna is long, curved dorsally, and fringed by numerous setae (not shown in the drawing). Each flagellum has 9 segments. The first antennae are long, longer than in the female, extending beyond the scape of the second antennae, each possesses 8 or 9 dorsal sensory papillae.

The trunk bears 18 pairs of swimming legs. The first and second pair are modified as typical gnathopoda. The fourth thumb-like endite of the first pair bears a lateral tubercle, the fifth claw-like endite bears a terminal sucker-like process, and the sixth endite is slightly elongate and digitiform (fig. 3). The second pair is similar except that the fifth endite does not

* Contribution from the Department of Biology, College of Agriculture and Mechanic Arts, University of Puerto Rico.



Figs. 1-7.—*Eulimnadia alineata* n. sp.—1. Outline of the shell of the male; 2. Lateral, outline view of the head of the male; 3. First trunk appendage (gnathopod) of the male; 4. Lateral view of telson; 5. Second gnathopod of the male; 6. Outline of the shell of the female; 7. Lateral view of the head of the female. (Scale for figs. 1 and 6 equal 1 mm.; all others, 0.5 mm.).

possess the tubercle and the sixth endite is slightly longer than the first (fig. 5). The number of body segments possessing dorsal spines varies from 10 to 13.

The telson (fig. 4) tapers abruptly to a pair of large terminal spines. In addition to these, the telson is spined on the two dorsal ridges, 9 to 12 pairs of spines being preesnt. The forked filament of the telson arises between the third and fourth lateral spines. The terminal, ventral spines are elongated, blade-like and microspined distally.

Female: The shell has an oval shape similar to that of the male, but with a more rounded ventral margin. The average length of the shell is 5.1 mm. with average greatest height near the center, 3.1 mm. (fig. 6). The female shell, like the male, has no lines of growth.

The form of the head is similar to that of the male, but with a shorter rostrum. The second antennae as in the male possess a varied number of spines on the flagella. The first antennae indicate sexual dimorphism in their much reduced length (fig. 7).

The swimming legs, 18 pair, are of the typical phyllopod type fringed with numerous setae. The flabellum of the first foot extends out the same distance as the tip of the sixth endite. The dorsal body spination and telson are similar to the male.

Eulimnadia alineata is distinctive in that there are no lines of growth on the shell. In other closely related species the number of growth lines are: *E. antillarum* (Baird)—2, *E. subtropica* Daday—1, *E. imnuta* Daday—2, and *E. diversa* Mattox—2. The form of the rostrum is similar to that of *E. diversa* and *E. thompsoni* Mattox. These two species differ from *E. alineata* in the longer sixth endite on both gnathopods and the presence of accessory tubercle on the fifth endite. Also *E. thompsoni* has 5 to 11 growth lines. *E. alineata* differs from *E. antelei* Mackin in the form of the shell, growth lines (5 in *E. antlei*), and in not having the pointed rostrum or the short flabellum of the first female swimming leg. *E. alineata* differs from *E. inflecta* Mattox in not having the inflected and pointed rostrum, shorter gnathopod fifth endites and in the growth lines (3 or 4 in *inflecta*). *E. stoningtonensis* Berry has 10 growth lines and is larger 8.5 by 6.0 mm.; *E. texana* Packard has 5 growth lines, 16 pairs of telson spines and is larger, 8 by 5 mm.; *E. agassizi* Packard has 4 growth lines, 12 pairs of telson spines, and is 6.2 by 3.8 mm.

Eulimnadia alineata seems to present another example of very local distribution as indicated for *E. agassizii, E. stoningtonensis, E. diversa* and *E. thompsonii.* However, future investigations may reveal a wider distribution for these forms. *E. alineata* also is an example of a species with a very unequal sex ratio. In the two collections, the first contained 8 females and 1 male, in the second collection there were 63 female and 7 male individuals. In *E. diversa,* it has been indicated that only 13% of those collected were males, in *E. inflecta* the ratio was 7 females to 3 males and in *E. thompsoni* there were 10 females and 2 males. The sexual dimorphism in the relative lengths of the first antennae of *E. alineata* is also found in the last three mentioned species.

The type locality for *Eulimnadia alineata* is Stuttgart, Arkansas.

Type specimens are deposited in the U. S. National Museum. *Holotype:* male, number 90713; *Paratypes:* number 90715, also in writer's collection.

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Effects of Temperature on Hatching and Growth of Lymnaea stagnalis appressa Say

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Hogg (1854) made the first observations on the rate of growth and development in *Lymnaea stagnalis*, but gave no data regarding the effects of temperature on the process. Semper (1874, 1881), in his studies on the effect of volume of water on growth, noted incidentally that when the temperature of his laboratory dropped to 13°C., the young *Lymnaea* ceased to feed and grow, and that the small snails at this temperature attained (in his 2-liter cultures) a length of only 3 mm. in 25 days, as contrasted with a length of 10 mm. at normal temperatures. Imai (1937) investigated the effects of temperature on growth in *Lymnaea japonica*. Other incidental observations on the effects of cold on freshwater snails have been made in connection with ecological studies and other investigations (Cheatum, 1934; Crabb, 1929).

This study was conducted at the University of Wisconsin under the guidance of Professor L. E. Noland, whose advice and cooperation is herewith gratefully acknowledged. The figures and graphs were prepared for the author by the Department of Medical Illustration, Bowman Gray School of Medicine.

Materials and Methods

The egg masses and young snails used in these studies were selected from a laboratory snail colony maintained in the zoological laboratory of the University of Wisconsin, and derived originally from a collection from Fox Lake, Wis., in 1939.

The apparatus used consisted of two controlled temperature cabinets: a larger one for temperatures from freezing to 28°C., and a smaller one for higher temperatures. The larger one (Fig. 1) was a wooden box 5 ft. long, 2 ft. 9 in. wide and 2 ft. deep, enclosing a somewhat smaller galvanized iron tank. The space between the walls of the box and tank at the sides and bottom was filled with insulating material (exploded mica). The tank was divided by one longitudinal and three transverse partitions into eight equal compartments in two rows of four each, a front and a rear series. The interior of each compartment was painted with black asphalt paint to prevent rusting. Glass plates covered each compartment, and squares of insulating board were placed over the glass plates to minimize temperature fluctuations and exclude light.

The right front compartment (No. 1) was kept filled with chopped ice and water, fresh ice being added twice daily, so that there was at all times unmelted ice in the compartment. In each of the remaining compartments

was placed a cylindrical, three-gallon, glass battery jar, nine inches in diameter and 12 inches deep, supported above the bottom of the compartment by two bricks. Outside the jar in the rear left compartment (No. 8) water filled the space to within two inches of the top (Fig. 2). Into this water was placed a heater and a glass mercury-tolul thermostat to maintain the water at 28°C. An aerator in the water maintained circulation, providing an even distribution of heat. Compartment 2, next to the ice compartment, was filled with water outside the jar (to facilitate cooling) and compartment No. 3 was filled half-way with water. The remaining compartments had air around the jars.

Equal volumes (about 12 liters) of Madison city water were used in each of the jars. The pH of the water at the beginning of all the experiments was between 7.2 and 7.5, as determined by the glass electrode method. A chemical analysis of this water was reported by Noland and Carriker (1946). An aerator continually circulated and oxygenated the water in each jar. As the water level was reduced by evaporation it was restored by the addition of glass-distilled water.

By placing sheets of insulating board against the partitions in the four compartments that had only air between the jar and the compartment wall, it was possible to adjust the temperatures in the cabinets at the outset in such

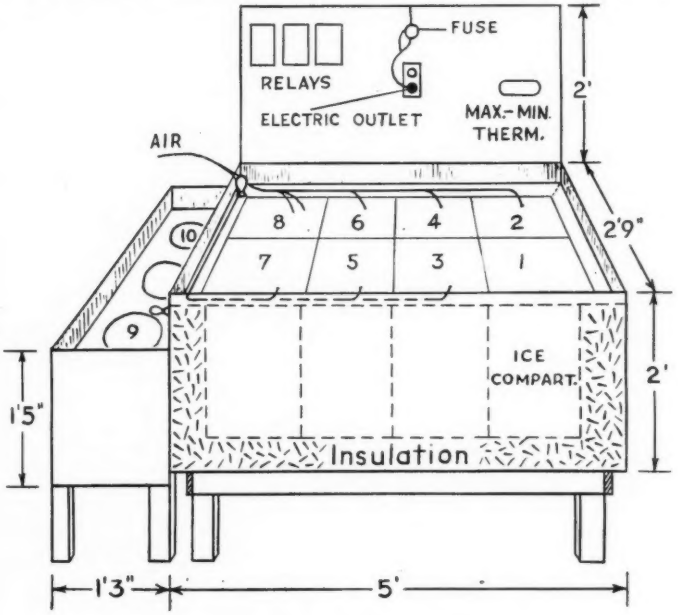


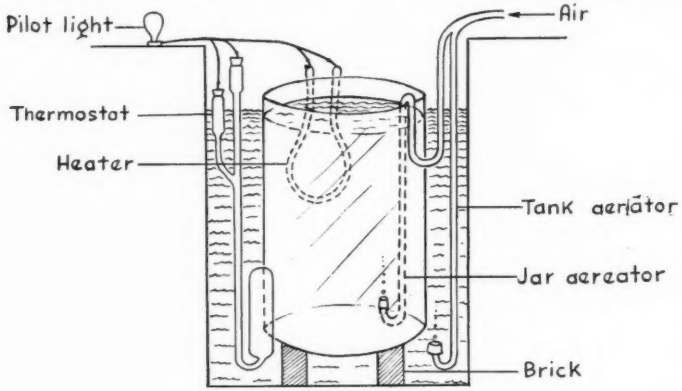
Fig. 1.—Diagram of temperature cabinets

a way that the average temperatures were maintained within approximately one-half degree of the following: Jar 2, 2.7°C.; Jar 3, 6.5°C.; Jar 4, 10.7°C.; Jar 5, 16.1°C.; Jar 6, 19.7°C.; Jar 7, 23.7°C.; Jar 8, 27.5°C.

The smaller temperature cabinet was a box 36 in. long, 15 in. wide and 17 in. deep, filled with glass wool insulation, except for three compartments just large enough to hold glass battery jars of the size already described. Each jar was supplied with a heater, thermostat and aerator, and during the experiments the temperatures were maintained at 27.5°, 32°, and 36°C., respectively. The jars were covered with glass plates and the exposed portions were covered with black paper and insulation. As a check on temperature variations, the temperatures of all jars were recorded daily in each experiment, and the maximum and minimum temperatures of the air in the laboratory were recorded by a maximum-minimum thermometer.

For the purposes of these experiments, hatching is defined as the escape of the young snail from the egg shell, rather than from the ootheca, since a delay of from two to seven days may occur before the young snail finds its way out of the latter.

The egg masses used were taken from the walls of the jars of the labora-



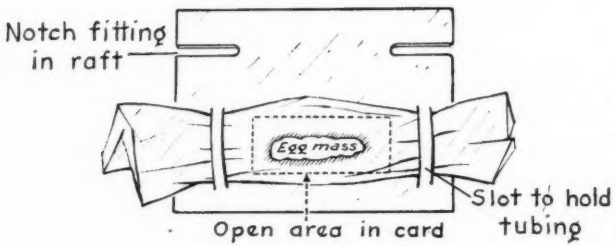


Fig. 2.—Diagram of tank 8 (upper).
Fig. 3.—Celluloid holder used in hatching experiments (lower).

tory snail colony. Removal was effected by using a razor blade mounted in a wooden handle. Egg masses were collected usually within an hour after being laid. When masses were removed without exact knowledge of the time of laying, the estimated time of laying was taken as half way between the time of previous examination of the jars and the time when the egg masses were found.

Only eggs in the zygote or early cleavage stages were used in the hatching studies, since it was found that in older egg masses, blastula stages looked superficially so much like uncleaved eggs that errors in recorded age might easily occur. As far as possible, masses containing more than forty eggs were used in order to provide a satisfactory statistical base for computing the percentage of hatching. The length of each egg mass and the number of eggs therein were determined by using a dissecting binocular microscope for the observations. In the relatively infrequent cases where anomalies occurred, a record was made of irregularly formed eggs, infertile eggs, and eggs with no ovum in them or with more than one. In a series of ten egg masses maintained at each of the temperatures listed above, egg development and hatching were observed and recorded.

EFFECTS OF TEMPERATURE ON HATCHING

The larger temperature cabinet was built by Prof. L. E. Noland and Mr. Robert Strasburg, and a preliminary run on the effects of temperature had been made by Mr. Strasburg before the present author took over the problem. For the construction of the apparatus and for permission to include the results of the trial run, the author is indebted to these men. In this first run, the egg masses were placed in short sections of large glass tubing closed at each end by open-meshed cloth to permit entrance of fresh water. The tubes were suspended from corks floating in the jars. Two (in one case, three) egg masses were placed in each tube. The times at which 50% of the eggs had hatched in this first run, were as follows: Jar 4 (near 10.7°C.): 57-61 days. Jar 5 (near 16.1°C.): 26-27 days. Jar 6 (near 19.7°C.): 17-22 days. Jar 7 (near 23.7°C.): 16-20 days. Jar 8 (near 27.5°C.): 17.5-18 days.

Comparison of these results with those of Table I (made later) will show fairly close agreement. However, the percentage of eggs that hatched was not as high as desired, due perhaps to inadequate aeration inside the glass tubes.

To provide better aeration, the present author developed a technique in which each egg mass was slipped inside a strip of 19 mm. cellophane dialyzing tubing, and the tubing was then mounted on a 3 x 5 in. celluloid card (Fig. 3). A rectangular section had been cut from the center of each card, and the egg mass was held over the opening by slipping the ends of the tubing through slits in the celluloid as shown in the figure. Notches were cut near the upper corners of the celluloid card, permitting it to be suspended on two slender aluminum strips, which in turn were fastened to glass shell vial floats at either end. In this way, egg masses were suspended about two inches below the water surface in the jars; and, since they were separated from the circulating water only by the thin, permeable cellophane on both sides, abun-

dant oxygen could diffuse in, but the young snails escaping from the oothecae were retained inside the tubing where they could be counted. Many egg masses so handled yielded a hatch of 100%.

In spite of the care taken to prevent it, some of the egg masses were torn slightly before they were placed in the tubes. However, the eggs that escaped from torn masses developed at the same rate and hatched as quickly as those inside the oothecae. At some of the lower temperatures, where development took a long time, it was necessary to replace the tubing at three week intervals because of softening and disintegration of the cellophane. The development in each egg mass was observed and recorded daily, and occasionally observations were made at more frequent intervals, as in the series run at 36°C.

The egg masses, mounted in the frames, were placed directly into the water of the battery jar in which they were to develop if the temperature of that jar was near room temperature; otherwise, to avoid shock to the eggs, the frames were first placed in a jar near room temperature and then passed successively through intermediate temperatures to the jars where they were to remain. A check was made to see whether direct transfer to the definite temperature would be injurious, but no unfavorable effect was found.

The series completed with the eggs thus held in the tubing is summarized in Table I. From the data there given, it is evident that *Lymnaea stagnalis* eggs will develop and hatch within a temperature range of 9.9° to 28°C. Above and below this range no hatching occurred. In Jar 4 (near 10.7°C.), none of the eggs in one mass of the ten hatched. The embryos in this mass developed until they filled approximately half the egg shell. There was a growth of water mold on this egg mass and on seven others of the ten in this series. Much of the superficial growth was removed with forceps at the time of the daily observations. Only on the one egg mass was the growth so great as to kill the embryos. When the series was discontinued this egg mass was carefully dissected and it was found that the oothecal membrane was completely filled with fungal hyphae. The hyphae did not penetrate the egg shells or membranes around the embryos. It is possible that the hyphae impeded the transfer of gases between the developing embryos and the surrounding medium or that they produced substances toxic to the embryos. It is interesting to note that, if the percentage hatch is calculated without including this particular egg mass, the figure would be raised from 77.8% to 87.6%, which compares favorably with the percentage hatch at other temperatures in spite of the longer period required for development.

Of all the eggs in the series that eventually hatched, the one that required the longest time was an egg in Jar 5 (near 16.1°C.), which took 59 days to develop. Some embryos lived longer than that without hatching at this temperature. However, all such embryos had died by the 70th day when the series was discontinued.

Because time was not available to make the necessary daily observations on ten masses in every jar, only five were run in Jars 6, 7, and 8 concurrently with the ten in Jars 2 to 5. The additional five masses for Jars 6 to 8 were run after the first set of observations was finished. These later series were started during the month of March, the time of year when the laboratory

TABLE I.—Experimental results of effects of temperature upon hatching time of *Lymnaea stagnalis appressa*

Jar	Temperature °C. Min.	Temperature °C. Max.	Total eggs in jar	Total eggs hatched	% eggs hatched	Total hatching time in days Min.	Total hatching time in days Max.	Maximum Hatching Time in days	Maximum Hatching % of total eggs hatched	Final pH of water
2	2.4	3.0	532	—	—	—	—	—	—	8.3
3	6.2	6.8	539	—	—	—	—	—	—	8.4
4	9.9	11.5	618	481	77.8	50	93	50 - 58	44.8	8.3
5	15.7	16.5	603	583	96.6	22	59	23 - 26	91.8	8.4
6	19.5	20.0	692	620	89.5	14	25	15 - 19	88.2	8.4
7	23.5	24.0	773	743	96.2	12	25	13 - 19	84.5	8.3
8	27.0	28.0	614	164	26.7	11	21	13 - 19	88.3	8.2
9	32.0	32.0	737	—	—	—	—	—	—	8.4
10	36.0	36.0	566	—	—	—	—	—	—	8.3

snail colony is commonly at its lowest egg-producing level. In Jar 6 (near 19.7°C.) there was a lower percentage hatch (83%) in the later five masses than in the earlier (96.2%). Although the percentage hatch was lower, the second group hatched at about the same rate as the first. In Jar 7 (near 23.7°C.), there was no marked difference in the percentage hatch in the earlier and later series; in the second run the time elapsing before maximum hatch was two or three days longer than in the first series. In the first five masses run in Jar 8 (near 27.5°C.), only 12.2% of the eggs hatched, but in the second five the percentage was 40.2% and the hatching continued over a longer period, raising the total percentage hatch to 26.7%.

In all the egg masses studied, it was found that the majority of embryos which did not hatch would develop and completely fill the egg shell before they died. The masses maintained at the 27.5°C. temperature exhibited the most unequal development of any series in the study. In addition to the snails which grew to the size of the egg shell, there were numerous "midgets," which were apparently perfectly formed, but only one-fourth to one-half the size of the snails that completed their development and hatched.

Imai (1937) observed that hatching in *Lymnaea japonica* began at 8-8½ days at 28°C.; 12-12½ days at 23°C.; and 16-17 days at 18°C. He also found that the shell was larger in snails raised at lower temperatures. He suggests that the animal grows and develops more rapidly at higher temperatures, using larger amounts of energy, and is thus of smaller size. A similar observation was made by Gray (1929) on trout, in which he pointed out that the metabolic balance between anabolism and katabolism is modified by the temperature during the growth period. Imai observed that hatching was effected by the mechanical action of the radula. He reported that the longer hatching was delayed, the weaker the action of the radula became and in a few cases the snails failed to hatch.

At 28°C. the hatching of *Lymnaea japonica,* as recorded by Imai, began earlier than that here observed in *Lymnaea stagnalis;* at 23-24°C. the two species began hatching at about the same time. There were no temperature observations in the present study to compare directly with his results at 18°C.

Although the measurements of the developing snails were not made in the present study, the snails that filled their shells in the series at 27.5°C. were among the largest seen in the entire group of experiments. It is possible that the reserve food material was used up so rapidly in the development of these snails that there was an insuffiicent amount remaining to furnish the energy needed for the radular movements that precede hatching. The occurrence of some "midget" snails in the 27.5°C. series parallels the appearance of smaller individuals in Imai's series at the same temperature; but the fact that both large and dwarf individuals occurred at that temperature in the present study, indicates that the effects of heat are not always the same in their end results on the organism.

In Jar 2 (near 2.7°C.) all the embryos were alive at the end of seven days, but all had died by the twelfth day. During the entire time they were at this temperature they showed no development, but remained in the stage they had reached when they were first put into the jar.

The eggs placed in Jar 3 (near 6.5°C.) were in various stages of development at the start, ranging from zygotes to four- and eight-cell stages. Within six days the cleavages had continued until the embryos resembled trochophores but were motionless. No further development occurred during the next 27 days. The only change noted was a slight redistribution of their materials, with the result that a clear disc was visible at one side of the embryos. The outlines of the embryos were irregular and many had become opaque. It was evident from the results in Jar 2 that it was only a matter of time until these embryos in Jar 3 would be dead if left at this temperature. In an attempt to see if any further development were still possible, the eggs in this jar were transferred at the end of 33 days to Jar 6 (near 19.7°C.). Four days after transfer all embryos were rotating rapidly within their egg membranes. All the embryos contained a large cavity surrounded by a layer of cells connected to an embryonic disc of cells at one end of the rotating embryos. Eleven days after transfer, many embryos had developed a shell and foot and appeared like normal veligers, except they still had the hollow vesicle attached to the body of the embryo. The vesicle disappeared during the following week, probably in part by resorption, as its size became smaller daily. Twenty-three days after the transfer one snail hatched, 56 days after the egg mass was laid.

Of the 539 eggs in this transferred series, 15 snails developed shells and reached hatching size. Eight of these were in one egg mass. These snails exhibited rasping movements for about three weeks after the one snail mentioned above had hatched. The radular movements eventually stopped, but the heart beat was observable in four of the eight snails for a period of 38 days after the first snail had hatched. The hatched snail was isolated in a battery jar in the laboratory, and remained alive for fourteen days. The unhatched snails remained alive for a total period of 98 days (since laying) but were unable to rupture the egg membrane surrounding them.

In Jar 9 (32°C.), extremely unequal development was observed. All the embryos were dead within four to ten days. However, the deaths were not uniformly distributed over the period, but seemed to occur in waves. Many of the embryos died in less than 24 hours in the one- and two-cell stages. If they survived these initial cleavages they would develop to the blastula stage. The next critical period was at the onset of locomotion in the trochophore stage. This stage would last from two to five days and between the fifth and seventh days veligers with well developed shells made their appearance. Only a few embryos reached the veliger stage, approximately 15 out of 737. Prior to the death of the embryos, a marked increase in their volume was noted. For example, trochophores would double their size and then would disintegrate very rapidly. This irregularity of size and shape may be the visible result of a disturbance in their osmotic regulating mechanisms at these critical periods.

Further evidence in support of this view was obtained in Jar 10 (36°C.). Three hours after immersion at this temperature the cells were observed to have approximately doubled in size. Correlated with this size increase there was a visible stratification of materials in the embryo which persisted even after death. Within 7½-21 hours all the embryos were dead. Throughout the entire series of egg masses run at this temperature there were numerous embryos in the two-cell stage. These varied from a relatively few equally divided

cells down to single cells with minute projections protruding from them, with divisions both unequal and incomplete. The embryos in one of the egg masses were in the four-cell stage when placed in the jar. When this mass was observed twelve hours later, it was noted that the third cleavage had occurred and the resulting quartets had separated from each other, resulting in twin embryos being present in all the eggs of this mass. Unfortunately they were all dead when discovered, and no further study of their development was possible.

In all the cases encountered in this study where there were two or more embryos within a single egg membrane, there were only two eggs in which both of the "twins" succeeded in hatching. Normally it was observed that neither twin would develop completely, except in cases where the development of one twin ceased during the early cleavages.

EFFECTS OF TEMPERATURE ON GROWTH

Newly hatched snails of this species show a definite tendency to climb the sides of the container and leave the water. This often results in the loss of young snails due to desiccation. After a week or ten days the snails no longer exhibit this tendency to any marked degree (Noland and Carriker, 1946). Snails recently escaped from egg masses were not used in these growth studies because of their migratory activities and because of the difficulties involved in handling such small fragile specimens.

Length of shell has been used in many studies of life histories of Mollusca, since it furnishes a definite, easily measurable index of growth. It has been found especially useful in research dealing with growth and life history of gastropods (Crabb, 1929; Forbes and Crampton, 1942). In the present study specimens were selected from two initial size groups: One in which the shell length ranged between 6-10 mm., and the other with shell lengths between 11-15 mm. Measurements were made weekly with a millimeter rule under a dissecting binocular microscope. The seven-day interval was sufficient to demonstrate the differences in size that occurred, and at the same time was long enough to prevent damage to the snails from excessive handling.

Fifty snails, including 25 in each of the above-mentioned size groups, were placed in each experimental jar. The volume of water (12 liters) was adequate to allow maximum growth and to eliminate any effects due to overcrowding. Forbes and Crampton (1942) have shown that overcrowding hinders growth in *Lymnaea palustris*. If there is any "group effect" in this species, such as that found in other forms by Allee et al. (1938), the arrangement of the experiment was such as to make this effect the same in all the jars (at least at the beginning of the experiment).

The snails to be used in the experiment were selected in the following manner. All the snails hatching in the general laboratory cultures during successive periods of 2-4 days each were placed in a separate container and each such group was labelled by a letter in alphabetical sequence to designate the relative age of the group. The snails in Jar A were thus several days older than those in Jar B, and so on. After a few of the largest snails in each group had been removed to perpetuate the laboratory stock, the groups of snails

used in the experiment were selected. Young snails from at least two different groups in each size range (6-10 mm., 10-15 mm.) were selected to make up the population for any one of the experimental jars. For example, the snails of the 11-15 mm. group placed in Jar 6 came from groups A and C and those in the 6-10 mm. range in the same jar came from groups D and E that had been segregated from the laboratory stock. Thus, rapidly-growing specimens from several diverse sources and of different initial sizes (within the limits stated) were obtained.

The snails were inspected daily at the time the temperature records were made. Once a week the snails were removed in a water bath maintained at the temperature of their experimental jar, and the shell lengths recorded. Record was made at that time of any abnormalities in appearance or behavior. Groups of 50 snails, selected as described above, were run in each of the experimental jars at average temperatures of 3.4°C., 6.9°, 11.5°, 15.7°, 20.1°, 24.2°, 28.1°, 32.0°, and 36.0°C. respectively, and one jar was run later with an average temperature of 24.1°C. as a control. Weighed amounts of lettuce were added as required to each of the battery jars to maintain a constant supply of food. Lettuce was chosen because it had been previously found that young snails would grow satisfactorily on lettuce alone, even to maturity and egg-laying. Wheat cereal, cooked to stiffness in milk, was used as a supplement in the regular laboratory colony, but was omitted in the experimental series because of the danger of putrefaction in the higher temperature ranges. Glass plates were placed on each of the jars in the large temperature cabinet because some of the snails crawled out of the water during the first day following initial immersion, and after their return to the jars following the weekly observations. In addition to retaining the snails, the plates aided in maintaining the constant temperature in the jars. When it was necessary to change the water in the jars, a fresh supply of water was heated to the correct temperature before transferring the snails to the clean water of the new jar. At the end of the experiment, the pH of the water in each of the jars was determined by the glass electrode method; the fecal material and debris from the food was collected and weighed. This data and the amount of food fed during the experiment are shown in Table II.

The size range of 6 to 15 mm. was chosen for the experimental snails because it had been the general observation on the laboratory colony (at room temperature, in the light and with optimum food conditions) that the snails grew most rapidly in this size range, and should accordingly exhibit most promptly the effects of subjection to different temperatures. Up to the time they were put in the temperature jars the experimental snails had been living at room temperature (about 22.0°C.).

Holm (1946) has shown that snails of this species in the 25-30 mm. shell size range are sexually mature. It was found that the snails at certain of the temperatures had more than doubled their size in six weeks to place them within this size range. This period of time, therefore, was regarded as sufficient to demonstrate the effects of temperature on growth rate, and accordingly all but one of the series was terminated at the end of a six weeks' period.

The results at the end of the first week (Table III and Graphs 1 and 2)

TABLE II.—Experimental conditions existing in the jars during temperature experiments upon the growth of *Lymnaea stagnalis appressa*

Jar	Temperature range in °C.	Variation in °C.	Amount of lettuce consumed	Amount of feces in jar	Final pH of water
2	3.0 - 3.8	0.8	5 gms.	2.1 gms.	8.4
3	6.8 - 7.0	0.2	10	6.1	8.5
4	11.0-12.0	1.0	15	4.8	8.5
5	15.5-16.0	0.5	115	4.7	7.6
6	19.8-20.5	0.7	270	12.7	7.3
7	24.0-24.5	0.5	285	12.0	7.0
8	28.0-28.2	0.2	65	7.9	7.2
9	32.0	–	15	–	–
10	36.0	–	—	–	–
9*	23.7-24.6	0.9	155	16.2	8.0

* Control series.

were about what one might expect: the snails at the 32.0° and 36.0°C. temperatures succumbed, those at the 6.9°C. level and below failed to grow, and those in the intermediate temperatures showed accelerated growth at the temperatures above room temperature and decelerated growth at the temperatures below room temperature, roughly proportional to the higher or lower temperatures respectively. It would appear that this result could be explained by assuming that there is a "biological zero" around 11°C. below which growth cannot occur, and a ceiling around 32°C. at which the harmful effects of excessive heat begin to make themselves apparent. Even though the growth was more rapid at 24.2°C. than at lower temperatures, it was evident in both jars run at that temperature that the mortality was somewhat higher than at 15.7° and 20.1°C. The mortality figures suggest that the optimum temperature for the growth and development of *Lymnaea stagnalis appressa* lies somewhere between 16° and 20°C.

By the end of the second week an interesting new phenomenon became apparent when the growth was plotted in the form of percentage increase over the previous week's mean snail size (Graph 1 and 2). The snails in the 24.0° and 28.1°C. jars slowed considerably in their growth rate, whereas those in the 15.7° and the 20.1°C. jars grew much faster than before. Since the two groups of snails maintained at about the same temperature near 24.0°C. showed a great similarity in growth, even though they were run several months apart, it seems unlikely that the above great variations could be a matter of chance. Neither does it seem likely that the drop in the growth rates of the 24.0° and 28.1°C. snail groups could be due simply to the heat hurrying these snails through their normal period of rapid youthful growth more speedily than the snails at lower temperatures, since there was a later spurt in growth in the groups of snails maintained at 24.0°C.

The data suggest rather that the snails have the power to adjust their rate of growth when it has been temporarily altered away from a basic optimum rate—a kind of acclimatization phenomenon. If the temperature rise is too great, the snails are unable to make the necessary adjustment and the unbal-

ance introduced is eventually lethal (as in the 28.1°C. jar). If the heat is not excessive the metabolism eventually becomes readjusted and growth continues normally thereafter (witness the second rise in the 24°C. jars). When subjected to lowered temperatures the metabolism is eventually adjusted upward and the growth rate after adjustment follows the normal pattern (see the 15.7° and 20.1°C. jars). If, however, the temperature falls below the "biological zero," adjustment becomes impossible, and growth ceases, the animals eventually succumbing to the cold (jars at 6.9° and 3.4°C.).

This interpretation is similar to the observations of Sayle (1928) on the metabolism of dragonfly nymphs. She found that "carbon dioxide output decreases progressively as the nymphs grow older," and that "higher temperatures caused increased rates of CO_2 output and lower temperatures tend to have the reverse effect. However, after an initial increase in CO_2 output following twenty-four hours of exposure to the high temperature, the output decreases again after longer exposure to the same temperature. The same effect is evidenced by the nymphs exposed to low temperature, *i.e.*, decrease in CO_2 output is followed by an increase after a longer period at the same temperature." The acclimatization response in the snails is much slower than that of the dragonfly nymphs, two weeks as against three days.

Sexual maturity, as evidenced by shell length, was reached within the six weeks' exposure to constant temperatures. The varied responses of the snails to the effects of these temperatures had narrowed greatly by this time (Graph 1 and 2), and indicated that further maintenance of snails at these temperatures would exert minimal effects on growth.

Belehradek (1935) lists the "biological zero" of *Lymnaea* as 12°C. The studies here reported show that this figure must be lowered slightly, at least for the variety *appressa*, since it was shown that development to the point of hatching will occur in the eggs of this variety between 9.9° and 11.5°C., and that some growth took place in young snails at a temperature of 11.0-11.5°C. The temperature of 12°C. listed in Table II as the upper limit of the temperature range only lasted for twenty-four hours during the six-week period. During the remainder of the time, the highest temperature recorded was 11.5°C.

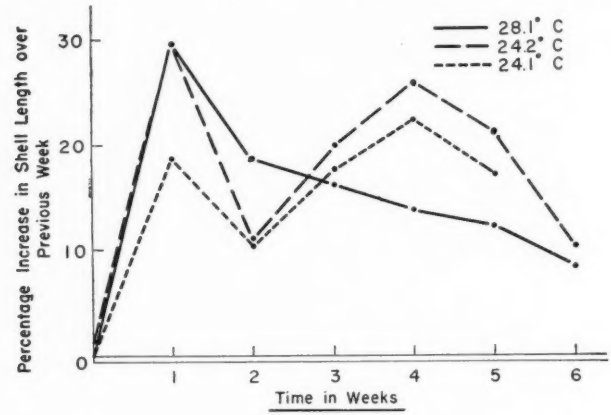
A group of snails belonging to this variety were collected from Fox Lake, Wisconsin, in July of 1942, by C. A. Herrick, D. DeGiusti and the author, and maintained throughout the winter in an aquarium in the lake laboratory of the University of Wisconsin in water ranging from 4° to 9°C. The snails moved about, ate and maintained themselves with a mortality of about 30%. Evidently the adults of this variety are better able to withstand cold than the eggs and young snails. Apparently it is not yet known in exactly what stage this species overwinters in nature.

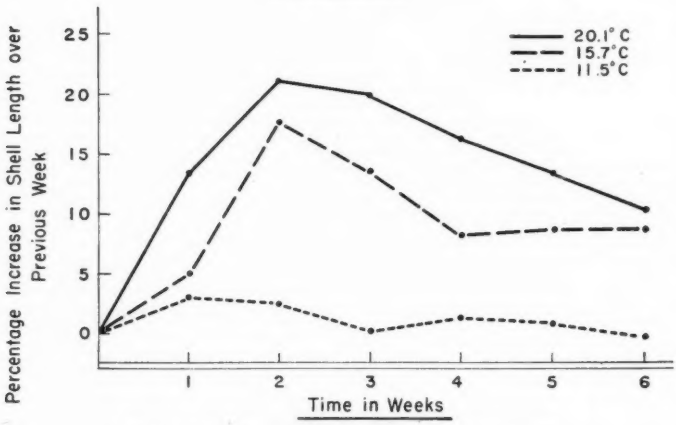
SUMMARY

Eggs of *Lymnaea stagnalis appressa* will develop and hatch at constant temperatures between 9.9° and 28.0°C. Embryos in eggs kept at 2.4-3.0°C. died within 12 days. Eggs kept at 6.2°-6.8°C. underwent cleavage, then remained unchanged for 33 days until removed to a temperature of 19.5°-20.0°C., where development proceeded, but only one egg actually hatched.

Failure of most eggs to hatch at 28.0°C., although development took place up to the prehatching stage, suggests that increased use of stored food in the egg left insufficient energy available for the radular movements necessary to hatching. Embryos in eggs kept at 32°C. died within 10 days; those kept at 36°C. died within 21 hours.

Growth takes place in young snails of this variety at constant temperatures between 11.0° and 28.2°C., with the least mortality in the 15.7° and 20.1°C. groups. The initial accelerating or decelerating effects of tempera-





Graph 1.—Growth curves of *Lymnaea stagnalis appressa* at various constant temperatures

Graph 2.—Growth curves of *Lymnaea stagnalis appressa* at various constant temperatures

ture seen at the end of the first week on snails of 6-15 mm. shell length are not uniformly maintained, but adjustment to a lower rate occurred in the 24.0° and 28.1°C. groups, while adjustment to a higher rate took place in the 15.7° and 20.1°C. groups by the end of the second week, suggesting an acclimatization had occurred. Snails kept at 32.0° and 36.0°C. died in the first week; those kept at 11.5°C. grew very little, and those at lower temperatures not at all.

TABLE III.—Effects of temperature upon growth of *Lymnaea stagnalis appressa*

Weeks at °C.	Range of snail size in mm.	Mean snail size	Weekly shell size increment In mm.	%	No. of living snails
3.4°C.	6.0-15.0	10.65	–	–	50
1	6.5-15.0	10.60	-0.05	-0.5	49
2	6.5-15.0	10.68	0.08	0.8	48
3	6.5-15.0	10.68	–	–	48
4	6.5-15.0	10.66	-0.02	-0.2	46
5	6.5-14.5	10.12	-0.54	-5.1	20
6	7.0-14.0	11.09	1.97	19.5	11
6.9°C.	6.0-14.5	10.14	–	–	50
1	6.0-15.0	10.18	0.04	0.4	50
2	6.0-15.0	10.23	0.05	0.5	50
3	6.0-14.0	10.18	-0.05	-0.5	49
4	6.0-14.0	10.23	0.05	0.5	47
5	6.0-14.0	10.08	-0.15	-1.5	46
6	6.0-14.0	10.12	0.04	0.4	43
11.5°C.	6.0-14.5	10.28	–	–	50
1	6.0-15.0	10.57	0.29	2.8	49
2	6.0-15.5	10.81	0.24	2.3	49
3	6.0-15.5	10.81	–	–	49
4	6.0-15.5	10.93	0.12	1.1	48
5	6.0-15.5	11.00	0.07	0.6	45
6	6.5-15.5	10.92	-0.08	-0.7	43
15.7°C.	6.0-15.0	10.53	–	–	50
1	6.0-16.0	11.04	0.51	4.8	50
2	6.5-19.5	12.97	1.93	17.5	50
3	7.0-22.0	14.70	1.73	13.3	49
4	7.0-23.0	15.89	1.19	8.1	49
5	8.0-26.0	17.22	1.33	8.4	49
6	8.5-28.5	18.66	1.44	8.4	49
20.1°C.	6.0-15.0	10.44	–	–	50
1	7.0-17.5	11.83	1.39	13.3	50
2	8.0-21.5	14.32	2.49	21.0	50
3	9.5-25.0	17.15	2.83	19.7	50
4	10.5-28.0	19.90	2.75	16.0	50
5	12.0-31.0	22.50	2.60	13.1	48
6	12.0-34.0	24.74	2.24	10.0	48
24.2°C.	6.5-13.5	9.85	–	–	50
1	6.5-17.0	12.79	2.91	29.5	48
2	6.5-18.0	14.14	1.38	10.8	48
3	7.5-23.0	16.85	2.71	19.2	43
4	7.5-27.5	21.17	4.32	25.6	42
5	18.5-32.0	25.59	4.42	20.9	41
6	21.0-34.0	28.07	2.48	9.7	41

TABLE III.—(*continued*)

28.1°C.	6.0-14.0	9.85	–	–	50
1	7.0-18.0	12.74	2.89	29.3	41
2	9.0-21.5	15.09	2.35	18.4	38
3	11.5-23.5	17.50	2.41	16.0	29
4	14.5-25.0	19.86	2.36	13.5	11
5	18.0-28.0	22.20	2.34	11.8	5
6	24.0 –	24.00	1.80	8.1	1
32.0°C.	6.0-15.0	10.62	–	–	50
	*(6.0-16.0	11.06	0.44	4.1	50)
36.0°C.	6.0-15.0	10.54	–	–	50
24.1°C.	6.0-14.5	10.04	–	–	50
1	7.0-18.5	11.90	1.86	18.5	49
2	7.0-20.5	13.10	1.20	10.1	48
3	7.0-24.0	15.35	2.25	17.2	47
4	9.0-28.0	18.74	3.39	22.1	47
5	13.0-30.5	21.92	3.18	17.0	46

* All specimens dead.

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Observations on the Morphology and Histological Anatomy of a Marine Nematode, Leptosomatum acephalatum Chitwood, 1936, New Combination (Enoplidae : Leptosomatinae)

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Several specimens of a marine nematode, males, females, and juveniles, were collected from a sponge, *Hymeniacidon heliophila*, at Beaufort, North Carolina, in the summer of 1949 by Rev. Wm. C. Kunsch. The worms were sent to the Department of Biology at The Catholic University of America for identification. Chitwood (1936) had previously found the male of this species at Beaufort, N. C., in sand. Because of the absence of cephalization in the male he created the variety *Leptosomatum elongatum acephalatum*. However, on the basis of the present collection we are elevating this variety to the rank of a species, *Leptosomatum acephalatum* Chitwood, 1936, new combination.

Little work has been done on the histological anatomy of the genus *Leptosomatum*. Chitwood and Chitwood (1950) figure and briefly describe some of the anatomical features of *Leptosomatum elongatum* var. *acephalatum* (now *L. acephalatum*). Histological studies on allied members of the subfamily Leptosomatinae Micoletzky, 1922, were carried out by Jägerskiöld (1901) on *Cylicolaimus magnus* (Villot, 1875) de Man, 1889; by Türk (1903) on *Thoracostoma strasseni* Türk, 1903; and by Rauther (1907) on the esophagus of *Cylicolaimus* and *Thoracostoma*. Their results will be correlated with the present study. In addition, comparisons will be made with *Enoplus communis* Bastian, 1865, of the Enoplinae, and with *Thoracostoma figuratum* (Bastian, 1865) de Man, 1893, and *T. magnificum* Timm, 1951, of the Leptosomatinae. The former two species were collected by the author at Woods Hole, Massachusetts, in the summer of 1950 from the encrusting protochordate, *Didemnum candidum*, while the latter is from Point Barrow, Alaska.

Materials and Methods

Ring mounts were made of adult male and female specimens in glycerine for the study of their morphology. Specimens were dehydrated for embedding following the method recommended by Elsea (1951). They were embedded for sectioning in beeswax-paraffin (m.p. 60-62° C.), a method

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which is especially suited to sectioning at 1-6 μ and is recommended for use with nematodes which are refractory to ordinary paraffin embedding. Longitudinal and cross serial sections were cut at 6 μ, and cuts of the cuticle were made at 2 μ. Camera lucida drawings were made at the magnifications indicated in the figures.

Leptosomatum acephalatum Chitwood, 1936, n. comb.
Figs. 1-3

Synonym.—Leptosomatum elongatum var. *acephalatum* Chitwood, 1936.

Taxonomic Description.—This nematode is elongate and filiform, with a tapering anterior and a bluntly rounded posterior. The female is usually somewhat longer than the male; the tail length in both sexes is less than twice the diameter of the body in the region of the anus. The cuticle is duplicated at the head (characteristic of the superfamily Enoploidea); it is somewhat thicker in the male than in the female: 8.3-8.5 μ at the anterior, compared with 5.2-6.5 μ in the female; 6-6.5 μ in the midbody region, compared with 4-4.9 μ in the female; and 7-7.2 μ at the posterior, compared with 5.7-6.3 μ in the female. The cuticle is finely striated, at least in the tail region. The head width and the width of the pocket-like (cyathiform) amphids are greater in the male; the amphids measure 6-7 μ across in the male, as compared with 4.9 μ in the female. Another feature of sexual dimorphism is the presence of an anterior "cap" of esophageal tissue in the female, with six pairs of fine sclerotized pieces symmetrically arranged around the "cap" (Fig. 1C; Fig. 2A). These pieces are nearly parallel and spread slightly at the posterior. The esophageal tissue of the male, on the contrary, is not organized in the form of a "cap" but tapers rather sharply towards the anterior end (Fig. 1H). The unusual sexual dimorphism is evident also in the intestine, since the female intestine in totomount view can be seen to have numerous very large cells of light color. These will be discussed under the section on histological anatomy.

In both sexes there are an internal circle of six short papillae—two lateral, two subdorsal, and two subventral—and an external circle of ten papillae—one pair of single lateral and two pairs of doubled subdorsal and subventral (Fig. 1I). The stoma is very inconspicuous, weakly sclerotized, and entirely surrounded by esophageal tissue. Three oval sclerotized prominences next to the ridges of the stoma indicate the orifices of the dorsal and subventral esophageal gland ducts (Fig. 1I). There are no odontia or onchia. Ocelli are present; in the female they are situated five "cap" lengths from the posterior indentation of the "cap."

	Male		Female
Length	7-7.3 mm.		6.6-8.5 mm.
α	59-73		45-67
β	6.2-6.9		6.3-7.9
γ	58-62		56-74
T	54-58% from anterior	V	54-58% from anterior
T	63% of body length	OV	36-52% of body length

The measurements of *Leptosomatum acephalatum* are based on three male specimens and ten female specimens, mounted in glycerine.

The testes and ovaries are both double; the ovaries are reflexed. A tuboid preanal supplement is lacking in the male. The gubernacula are two simple straight pieces on either side of the spicules, forming a ring at the anus through which the spicules pass; no median connecting piece was seen in cross section. The gubernacula measure 42 μ. The spicules are paired and equal, 83 μ in length.

Habitat.—Marine; in the sponge, *Hymeniacidon heliophila* (Parker) de Labenfels.
Locality.—Beaufort, North Carolina; collector: Rev. Wm. C. Kunsch.
Specimens.—U.S.N.M. Helm. Coll. No. 47098 (hypotype female).

Diagnosis.—Leptosomatum with the above measurements and general description. Distinctive in that the male lacks a "cap" of esophageal tissue with six pairs of thin sclerotized pieces, as in the female.

The present species is similar in many respects to *L. elongatum* Bastian, 1865, and *L. sabangense* (Steiner, 1915) Micoletzky, 1930. Comparative measurements are given in the table below (Table 1). The values for *L. elongatum* are based on the description of de Man (1893), those for *L. sabangense* on the description of Steiner (1915), and those for *L. acephalatum* on the description of Timm (present paper).

TABLE 1.—Comparative measurements of *Leptosomatum acephalatum*, *L. sabangense* and *L. elongatum*

	♂ *L. acephalatum*	♀ *L. acephalatum*	♀ *L. sabangense*	♂ *L. elongatum*	♀ *L. elongatum*
Length	7-7.3	6.6-8.5	9.8	11.5	14.5
α	58-62.5	45-67	80	100-130	90-100
β	6.2-6.9	6.3-7.9	7.2	7-7.5	8-9
γ	58-62	56-72	60.5	56-74	115-140

De Man reported a maximum of forty eggs in the uterus of *L. elongatum;* we have found eleven at most in *L. acephalatum* when the uterus is filled. De Man saw a fine suture around the head in *L. elongatum,* immediately behind the posterior papillae; we have failed to see any in *L. acephalatum.* He wrote that the sclerotized pieces are lacking in the dorsal region of the head, while we have described them as symmetrically distributed around the head. Since de Man's description is careful and detailed, we feel that he would certainly have mentioned the interesting and unusual sexual dimorphism in head characters if it were present in *L. elongatum;* in other lesser respects, e.g. in the appearance of the intestine, he cites the differences between male and female. Unfortunately, he gives a drawing only of the female head. However, our size differences alone would be sufficient to constitute a new species separate from *L. elongatum.*

L. sabangense, according to the description of Steiner, is somewhat longer than *L. acephalatum.* The ratio of maximum body diameter to total length is much greater in *L. sabangense.* The latter likewise has a suture at the head.

The esophageal tissue of the female of *L. sabangense* is not concentrated at the anterior in the form of a "'cap."

HISTOLOGICAL ANATOMY

CUTICLE

Like all nematodes, *Leptosomatum acephalatum* is invested exrernally with a non-cellular cuticle around the entire body. The various layers of the cuticle of *Leptosomatum* can be observed most readily in transverse sections at 2 μ and in cross sections at points where the cuticle has separated from the hypodermis and somatic musculature. At least six layers are present in the external cuticle. They are as follows: 1. An outer thin cortical layer, which is homogenous and does not ordinarily stain. 2. A thin external layer of oblique fibers, closely applied to the above layer. This layer stains with hematoxylin. 3. A somewhat thicker internal layer of oblique fibers, crossing the above layer at an angle. This layer stains readily with eosin. 4. A thin external matrix layer which stains faintly with eosin. 5. A thick internal matrix layer, which does not stain with eosin or hematoxylin, but stains a light yellow with Orange G and purple with Orcein. The entire matrix layer comprises about half the cuticle: it is much thicker in the anterior and posterior of the worm. 6. A basal lamella, containing longitudinal fibrils. It stains darkly with haematoxylin and has a punctate appearance.

De Man (1886) reported seven layers in the cuticle of *Enoplus communis* of the subfamily Enoplinae; in addition to the layers we have reported for *Leptosomatum* there is a row of punctations in *Enoplus* just above and extending into the matrix. Jägerskiöld and Türk described two cuticular layers in *Cylicolaimus* and *Thoracostoma* respectively, though Jägerskiöld possibly found a third layer in some regions. Upon examination of *Thoracostoma figuratum* and *T. magnificum* we find that they have the same cuticular layering as *L. acephalatum* and feel that this condition is perhaps characteristic of the subfamily.

The external cuticle turns into the cloaca (male) and the rectum and vulva (female). The lining of the rectum consists of three cuticular layers, including a fiber layer, the matrix layer, and the basal lamella. All the layers of the cuticle turn in at the vulva to the outermost end of the sclerotized pieces lining the vagina (Fig. 3F).

The esophageal lining of *Thoracostoma* is much thicker than that of *Leptosomatum* and has cuticular attachment points for the radial muscles; attachment points are found in *Cylicolaimus* also (Jägerskiöld).

HYPODERMIS

The hypodermis consists of a thin cellular layer immediately beneath the external cuticle. It is divided into four longitudinal thickenings or chords, two lateral, one dorsal, and one ventral, with modifications in different regions of the body. The hypodermal cells are never syncytial. There are no nuclei in the interchordal areas, although a thin tissue extends along the basal lamella between chords. Jägerskiöld pictures subventral hypodermal chords in the the esophageal region of *Cylicolaimus*, but they are not shown in the cloacal region. Türk described 4-5 cell rows in each lateral chord of *Thoracostoma*,

beginning at the nerve ring. In *L. acephalatum* there appear to be 4-5 rows in this region because of division, but only three cell rows border on the cuticle. The extra rows attach to the esophagus by means of mesenterial tissue (Fig. 2C).

The dorsal and ventral chords begin as a double cell row of large cells at the level of the amphids. The lateral chords begin as a row of single large cells immediately behind the amphids and divide into a three-cell row behind the ocelli. Before the nerve ring the dorsal and ventral chords are very large with a narrow tapering base. Between the ocelli and the nerve ring they become single, and behind the nerve ring they are extremely reduced in size, especially the dorsal chord, which is often difficult to observe. All the chords are nucleated before the nerve ring, but no nuclei are present in the dorsal chord behind this level. The lateral chords become very large toward the end of the non-glandular region of the esophagus and continue as the dominant chords for the remainder of the body length. They flatten out in the region of the gonads, a tendency which is most noticeable in mature females, in which the lateral chords may extend around most of the body. In the region from the esophago-intestinal valve to the anus the dorsal chord is seen as a single tiny rod-like cell and the ventral chord is variously seen as single or double-celled (Fig. 3A).

In the postanal region the ventral chord is large and double immediately behind the anus, the dorsal chord disappears, and the lateral chords spread out around the caudal glands. The lateral chords end a short distance before the end of the caudal glands.

All the hypodermal chords stain deeply with hematoxylin. They are somewhat vacuolate in appearance, probably due to the dissolving out of stored fats and glycogen. There is a dark-staining reticular network traversing the cells.

Arcade cells, a cephalic modification of the hypodermis, have been described in the Aphasmidia only in the genus *Siphonolaimus* (Chitwood and Chitwood, 1950). No arcade cells have been observed in *Leptosomatum* or *Thoracostoma*.

Three large elongate caudal glands are found in both male and female *L. acephalatum*. In the female they are attached at their anterior end by the same broad mesenterial band which anchors the posterior ovary. The most anterior gland begins about halfway between the posterior gonad and the anus. Each of the glands has a single nucleus, which is at the anterior end. Behind the anus the caudal glands fill most of the body cavity. They do not form a common tube at their proximal end but meet at a small cone, the spinneret, which opens terminally through the cuticle by way of the tube pore. Embedded in the cuticle and symmetrically arranged around the spinneret are four small ovoid sclerotized plates, from each of which a single papilla projects (Fig. 1E). The caudal glands are deeply basophilic.

Numerous and prominent lateral hypodermal glands were reported by Jägerskiöld and Türk for *Cylicolaimus* and *Thoracostoma* ("Hautdrüsen"). These glands are not as prominent in *L. acephalatum* (Fig. 2E). Many have

clearly visible ducts leading to the cuticle but only rarely have we detected a duct passing through the cuticle; probably most of the pores are too minute to be disclosed. These hypodermal glands occur in sublateral rows in the lateral chords of most of the body posterior to the esophago-intestinal valve.

SOMATIC MUSCULATURE AND BODY CAVITY

Unspecialized musculature.—There is a strong somatic musculature throughout the body. It consists of a single layer of longitudinal muscle cells attached to the hypodermis and separated by the hypodermal chords into four primary fields, the dorso-submedian and ventro-submedian sectors. In the anterior region of the esophagus there are only 6-7 muscle cells per sector, but behind the nerve ring to the posterior end of the body there are 10-12 cells per sector. *Leptosomatum*, therefore, is polymyarian.

The muscle cells are spindle-shaped, with broadly elliptical nuclei situated in the sarcoplasm above the fibrous portion of the cell. In cross section most of the muscle cells appear V-shaped at their free end in the body cavity; in such cells the nucleus rests in the groove between the two tips of the cell. The cells are coelomyarian, i.e. the muscle fibers extend up the sides of the cell but do not cross it entirely, though the separation of these fibers in the center of the cells cannot always readily be seen. The somatic musculature, as well as all the specialized muscles of the body, is eosinophilic.

Thoracostoma has taller, thinner, and more numerous muscle cells than *Leptosomatum*, with a greater amount of sarcoplasm. Many of the cells seem to have fibers completely crossing them, but a refractive separation can usually be seen in the center of the cell.

Specialized musculature.—The specialized muscles include somato-esophageal, somato-intestinal muscles, and those muscles associated with the vulva, rectum, cloaca and anus. They are all circomyarian, i.e. the fibers go completely around the sarcoplasm.

FEMALE

Levator recti: In the female there is a large V-shaped muscle at the posterior part of the rectum, attached to the subdorsal body wall and inserted near the dorsal center of the rectum. This V-shaped muscle has two thin lateral connectives which meet in the center of the caudal glands and are attached by a third connective to the dorsal body wall. A large nucleus lies at the center of these three connectives (Fig. 3G). There is likewise a small pair of muscles originating from the subdorsal body wall, winding around the lowermost caudal gland, and inserting on the anterior part of the rectum. These muscles serve to elevate the dorsal wall of the rectum and allow defecation.

Dilator vulvae: Anterior and posterior to the vulva there are 10-12 pairs of muscles which run from the ventro-lateral body walls to the sides of the vagina and vulva (Fig. 3F). The most lateral pair attach at the junction of the uterus and vagina and the most central pair attach at the lips of the vulva. There is a single nucleus for each muscle; the nuclei are all situated at the same level near the origin of the vulvar muscles at the body wall. In *Thoracostoma figuratum* there are fewer pairs of dilator vulvae muscles (6-8).

Levator vaginae: Anterior and posterior to the vulva 5-6 pairs of muscles extend from the dorso-lateral body wall to the dorsal side of the vagina. They probably serve to elevate the vagina to allow the passage of eggs from the uterus into the vagina.

Constrictor lateralis vaginae: Two thick muscle masses, each with a single large nucleus, lie anterior and posterior to the vagina and partially surround it (Fig. 3F). They probably serve to constrict this tube, thus closing the vulva.

Constrictor dorsalis vaginae: Two muscle cells lie directly dorsal to the vulva and vagina and may serve to regulate the vulvar "plug" pictured in Fig. 3F. *Thoracostoma figuratum* has two huge muscle masses on either side of the vagina, serving as constrictors of the vagina. Türk has described a constrictor vulvae in *T. strasseni.*

Sphincter uteri: There is a much reduced sphincter muscle near the juncture of the uterus with the vagina. This muscle layer which enlarges to form the sphincter continues as a thin layer around the vagina. Jägerskiöld described a vaginal sphincter in *Cylicolaimus.*

MALE

Levator ani: The levator ani is a V-shaped muscle from the subdorsal body wall to the posterior lip of the anus; the nucleus is at the body wall. There is a thin paired muscle outside it, which attaches to the upper side of the lateral chords; the nucleus is on one side.

Copulatory muscles: Numerous thin paired muscles (about 38 pairs) extend from the ventral sides of the lateral chords to the subventral sides of the body in the region immediately anterior to the anus (Fig. 3B). Two or three pairs of short muscles from the ventrolateral body wall to the anterior lip of the anus resemble the copulatory muscles; probably they function in elevating the lip of the anus. Türk reported copulatory muscles posterior to the anus in *Thoracostoma;* none have been found in *Leptosomatum.*

Retractor spiculi: This paired muscle originates at the body wall dorsal to the lateral chords and inserts on the capitulum of the spicule. The nuclei are contained in the sarcoplasm of the somatic muscle layer.

Protractor spiculi: The paired protractor muscles form a longitudinal layer on the dorsolateral surface of the spicular pouch. They have elongate nuclei. Their origin and insertion could not be determined.

Retractor gubernaculi: The paired retractor muscle leads from the dorsal body wall and attaches to the proximal end of the gubernaculum.

Somato-intestinal muscles: Beginning shortly behind the esophagus in the male there is a prominent thick irregular muscular "sheath" surrounding the intestine but not adhering to it. It consists of irregular longitudinal blocks of muscle tissue loosely joined. These muscles are free in the body cavity. They are attached by strands of muscle to the somatic muscle layer or the body wall. The nuclei are usually in the sarcoplasm of the muscle layer, but may also be found between the somatic layer and the muscular "sheath" or on the outer edge of the "sheath." The "sheath" also partially surrounds the testes and vas deferens in the posterior region of the body (Fig. 3A). Behind

the distal ends of the testes the muscle of the "sheath" concentrates in a large block, attaching the testes firmly. The muscular "sheath" stains much more brightly with eosin than the other muscle tissue of the body. With Orange G it stains yellow, the same as the matrix layer of the cuticle. With Bismarck brown the muscle "sheath" stains brown, while only the fibers of the body muscle layer stain this color.

COMMON TO BOTH SEXES

Retractor spinnereti: The valve of the spinneret is withdrawn by means of a thin muscle which passes through the middle of the caudal glands and fans out between the three gland tubes. It attaches to the body wall. In *Leptosomatum* and *Thoracostoma figuratum* the retractor spinnereti has a dorsal nucleus at the body wall.

Somato-esophageal and somato-intestinal muscles: There are short muscle strands with prominent nuclei extending from the body wall to the esophagus and the intestine a short distance above and below the esophago-intestinal valve. These muscles seem to function in anchoring the mesenterial tissue which is abundant in the body cavity at the level of the valve (Fig. 2E). There is no regular symmetrical arrangement of these muscles.

In *Enoplus communis* de Man (1886) described four median muscles from the base of the esophagus which run forward and fuse with four sublateral muscles and attach to the body near the submedian line; each is a single cell. Türk also described somato-esophageal muscles in *Thoracostoma*, but we have failed to confirm this observation.

Coelomocytes.—In the female a paired row of large basophilic cells lies free in the body cavity along the region of the uterus (Fig. 3E). There are also a few at the end of the seminal receptacle and many along the oviduct. The coelomocytes have a single central nucleus; some are bifurcate at one end. They are supported in a mesenterial band which is attached to the body wall along the uterus by a glazed band. In *Enoplus* branching coelomocytes form a network over the intestine. In *Thoracostoma magnificum* we have observed prominent unbranched coelomocytes. Jägerskiöld found free cells in the anterior esophageal region of *Cylicolaimus*, which he thought are probably homologous to the stellate cells ("büschelförmige Zelle") of *Ascaris;* thirteen such cells are pictured (Pl. 4, fig. 1).

DIGESTIVE TRACT AND ASSOCIATED STRUCTURES

STOMODEUM

Stomatal region: The stomatal region is entirely surrounded by esophageal tissue. The second cross section at 6 μ shows six pairs of sclerotized pieces which are found only in the female; each pair is spread out in triangular fashion from a common anterior point near the stoma (Fig. 2A). The sclerotized pieces as figured appear broader than in totomount view due to their refractiveness when traced up and down. The subdorsal gland ducts open a short distance behind the stoma. In the extreme anterior the subventral ducts appear to be lined with heavy cilia-like projections. These "cilia" are basophilic, the same shade as the large secretory granules of the glands, and may represent merely a peculiar condensation of the gland secretion.

Jägerskiöld in *Cylicolaimus* and Türk in *Thoracostoma* found the dorsal gland to end blindly before the nerve region. Rauther found it opening in *Thoracostoma* 110 μ from the anterior and in *Cylicolaimus* 150 μ from the anterior; the orifice was not through the dorsal tooth. He was not certain whether the subventral glands open through the subventral teeth. In *Thoracostoma figuratum* we found the three gland ducts opening through the three small teeth. The two subdorsal ducts open at the same level, though not through the teeth. The violet pigment of these ducts is much lighter than the dark blue pigment (with hematoxylin) of the other gland ducts. In *T. magnificum* the dorsal gland duct opens through a dorsal tooth, while the subventral ducts open at the anterior. Jägerskiöld pictured two "subventral tunnels" at the extreme anterior of *Cylicolaimus* without explaining what they were meant to be. Rauther describes small accessory subventral ("lateral") gland ducts leading to the eye. We have found such ducts in *T. magnificum*. At certain points the ocellus pigment lies across the ends of the subdorsal esophageal radii and unites the subdorsal and the accessory ducts. However, these accessory ducts never merge with the subdorsal ducts; their orifice at the extreme anterior could not be determined.

Esophagus: The esophagus of *L. acephalatum* is triradiate, with the sides of the radii nearly parallel and converging distally. The esophagus consists of two regions, a short non-glandular anterior part (approximately one-third of the esophagus) and a long posterior glandular part. The non-glandular portion is eosinophilic, with light concentered radial muscles. The glandular portion is basophilic, with heavy concentered radial muscles. Towards the anterior end of the esophagus there are two ocelli with a red-pigmented "retina" and a crystalline lens half-embedded in the dorsolateral walls (Fig. 2B). Diffuse pigment of the same color as the ocellus pigment runs throughout the esophagus in the area of the three esophageal radii and is often concentrated near the ocelli.

There are no nuclei in the esophagus anterior to the ocelli. The first two nuclei are two large marginal nuclei directly behind the eyes. Timm (1951) has suggested that these nuclei may serve as activators for the production of the ocellus pigment. The nuclei of the corpus of the esophagus are presented below in map form (Table 2), according to the different levels and sectors in which they occur. Comparison is made in tabular form (Table 3) with *Enoplus communis* of the related subfamily Enoplinae, for which an esophageal nuclear map has been worked out (Chitwood and Chitwood, 1937). The number of nuclei in the corpus of *Leptosomatum* is the same as that in *Enoplus*, except for the addition of two definite nuclei of questionable type (s_1 and s_2) in *Leptosomatum*. In serial sections of three esophagi we have constantly found a fourth nucleus in the dorsal sector at the level of the first group of nerve cell nuclei (n_{1-3}). The other questionable nucleus is at the level of marginal nuclei 4-6.

In the glandular region of the esophagus the first three marginals (m_{7-9}) and the dorsal gland nucleus (g_1) can be clearly distinguished. However, due to excessive division of the subventral gland nuclei the majority of the nuclei of this region could not be assigned a type; over 200 nuclei are found

in the glandular portion of the esophagus, most of which are the result of mitotic division and not the product of nuclear fragmentation. They lie in various positions and lack the symmetrical arrangement found in the corpus.

TABLE 2.—Map of nuclei in the esophageal corpus of *Leptosomatum acephalatum*

Right subventral	Dorsal	Left subventral
m_3	m_1	
	r_1	m_2
r_6		
	s_1	r_2 r_3
r_4 r_5	n_1	n_2
n_3	r_7	r_8 r_9
r_{12}		
r_{10} r_{11}	n_4	n_5
n_6	r_{13}	r_{14} r_{15}
r_{16} r_{17}	r_{18}	
	n_7	n_8
m_5 n_9 m_6	s_2 m_4	
n_{11}		r_{10}
	n_{12}	n_{13}
n_{14}		n_{15} n_{16}
n_{17} n_{18}		
n_{21}		n_{20}
	n_{19}	n_{22}
n_{23}		n_{24}
n_{25}		
r_{24}		r_{20}
r_{23}		r_{21}
	r_{19}	
r_{22}	n_{26}	

Abbreviations: m-nuclei of marginal fibers. n—nuclei of nerve cells. r—nuclei of radial fibers. s—nuclei of questionable type

TABLE 3.—Comparison of nuclei in the esophageal corpus of *Enoplus communis* and *Leptosomatum acephalatum* (see table 2 for abbreviations)

Enoplus	*Leptosomatum*
m 1-6	m 1-6
r 1-24	r 1-24
	s_1 and s_2
n 1-26	n 1-26

There are three sets of large nuclei in the glandular region which resemble the dorsal gland nucleus, though they are only half as large. The nucleoli are large and the nucleoplasm is relatively free of granules, as in the dorsal gland nucleus (Fig. 2D). These nuclei lie next to the esophageal lumen between the radii in each of the three sectors. There are three at the same level just above the esophageo-intestinal valve; the others are in two somewhat widely separated sets. The upper set just beneath the level of the dorsal gland nucleus contains only two nuclei; the nucleus of the dorsal sector is lacking. We offer no explanation of the type or significance of these unusual nuclei.

Esophago-intestinal valve: At the juncture of the esophagus with the intestine there is a well-developed valve. This consists of esophageal tissue surrounded by a thin circular muscle sphincter, which in turn is surrounded by the foremost intestinal cells. The esophageal tissue of the valve contains three nuclei (V_1-V_3). The circular muscle contains seven nuclei (v_1-v_7). The portion of the intestine which surrounds the valve often contains a double row of large nuclei (Fig. 2E).

MESENTERON

The intestine is a straight tube running from the juncture with the esophagus to the anus. It is polycytous, i.e. there are more than 128 and less than 5000 cells. The intestinal cells are isocytous, i.e. of equal height, and heterocytous, i.e. with scattered specialized cells. Cellular inclusions could not be identified in most specimens; possibly the highly vacuolate plasma indicates the location of fat or glycogen depots which were extracted by the alcohol preservative. A few basophilic granules are present. There is a bacillary layer which is quite prominent just behind the esophago-intestinal valve; long rod-like basophilic filaments can be seen (Fig. 2F). There is some evidence of a thin eosinophilic subbacillary layer. Rauther could not detect a bacillary layer in *Thoracostoma* and *Cylicolaimus* but we have observed a well-defined basophilic bacillary layer and a prominent eosinophilic subbacillary layer in both *T. figuratum* and *T. magnificum*.

There are prominent heterocytes in the intestine of female *Leptosomatum acephalatum* which can be termed "oval cells" because of their shape (Fig. 3D). They are 2-3 times longer and wider (21 by 27 μ) than the normal intestinal cells. They have a basal nucleus and a coarse basophilic reticular network. These cells resemble goblet cells; the most anterior have a "plug" bordering on the bacillary layer which resembles the mucus secretion in the neck of goblet cells. Such "plugs" cannot be seen in the posterior heterocytes, in which the vacuolate cells border directly on the bacillary layer along their entire length. Chemical tests of fresh material will be necessary to determine whether or not the "oval cells" are true mucus-secreting goblet cells. Possibly they merely represent the site of more abundant fat and glycogen storage in connection with egg development, since they are rare in males and juveniles. We have not found any heterocytes in *T. magnificum* and *T. figuratum*, though Türk described "Fettzellen" in the intestine of *T. strasseni*.

The intestine is compressed dorsad by the gonads. However, it remains functional even when the female is full of large eggs, as is evidenced by the large food masses in the lumen of the adult female intestine. Probably the worm is a detritus feeder, taking in fine organic particles and bacteria, since many birefringent granules and rod-shaped particles (bacilli?) were seen in the lumen. In the posterior region the intestine is indented successively by the three caudal glands. The "oval cells" disappear a short distance before the rectum. Just before the rectum the intestinal cells are much enlarged (Fig. 1D).

The intestine of the male is somewhat variable. There are always fewer intestinal cells than in the female and very few "oval cells," confined to the central portion of the intestine. Some males show wide flattened cells, almost

cuboidal, which are larger than the normal intestinal cells in the female; other males show high columnar cells. The male intestine tends to disintegrate more readily. It is compressed in the region of the gonads but not as much as in the female.

PROCTODEUM

In the female the rectum is entered through an intestino-rectal valve surrounded by epithelial tissue. The cuticle of the rectum extends up to the intestine, leaving no naked strip between intestine and rectum. At the anterior of the rectum there are numerous finger-like projections into the lumen, apparently due to a condensation of the fiber layer of the rectal cuticle (Fig. 3G). There is likewise a thin muscular sphincter surrounding the rectum at this point and extending around the extreme posterior of the intestine (Fig. 1D). The mid-rectum and posterior rectum are dorso-ventrally flattened and there are four large epithelial cells dorsal and ventral to the rectum at about the level of the anal ganglia. There are no rectal glands.

In the male the intestine and vas deferens unite shortly before the anus. There is no rectum preceding the cloaca.

EXCRETORY SYSTEM

There is no excretory gland cell in *Leptosomatum acephalatum*. Jägerskiöld and Türk report its absence in *Cylicolaimus* and *Thoracostoma;* we confirm this observation for *Thoracostoma.*

REPRODUCTIVE SYSTEM

Female.—The female reproductive system is didelphic, i.e. there are two ovaries, which are reflexed, and amphidelphic, i.e. the two uteri are apposed at the point of their origin from the vagina. The female system consists of a ventrally-opening vulva, a vagina, and paired uteri, zones of egg shell formation, seminal receptacles, oviducts and ovaries.

Ovary: Each ovary begins subdorsally and is connected to the muscle layer by mesenterial tissue near the distal end of the uterus. The ovary is terminated by a cap cell, an elongated cell with a single nucleus. Numerous flat cells lie on the outer surface of the spongy cap cell; they seem to be epithelial cells of the ovarian epithelium. The epithelium is thin with flattened nuclei; fibrils can be seen in the lining of the ovary. In *T. figuratum* there are large flat epithelial cells all along the ovary. In the extremely short germinal zone of *L. acephalatum* there are many minute cells staining with hematoxylin. In the growth zone the cells are larger and become pyramidal (Fig. 3D). Before the reflex of the ovary the cells become large, oval and eosinophilic. The nuclei are round or oval, in contrast with the fusiform-elliptical nuclei of *T. figuratum* eggs. At the ovarian reflex there are many nuclei of the ovarian epithelium. It is difficult to imagine how the large eggs can make the turn of the ovary; this obstacle caused Jägerskiöld to say that the ovarian eggs are enclosed in a "Blindsack." However, in one specimen we observed an egg at the reflex; the thin nuclei and epithelial lining of the ovary could be seen separating the two halves of the egg. In young adult females sperm have been in the "Blindsack" of the ovary. Türk had the

good fortune to see an egg turn at the "Blindsack" and pass along the ovary in a living *Thoracostoma*.

Oviduct: In the mature females the oviduct shows up for most of its length merely as a collapsed spongy tissue against the ventral wall of the body between the intestine and the ovary. No lumen was seen but an occasional flat nucleus suggests the presence of the oviduct epithelium. In one younger specimen the oviduct was still intact and the unshelled eggs could be seen passing down it to the uterus. In one unusual specimen of *Leptosomatum* there was a second row of eggs passing ventral to the intact portion of the oviduct. The eggs were surrounded by an epithelial lining which was bound to the sublateral body walls by a thick mesentery. No explanation is offered for this phenomenon.

Seminal receptacle: There is no separate seminal receptacle set off from the reproductive canal, as in many of the free-living nematodes. The sperm are found among the eggs in the uterus, among the large cells in the region of shell formation directly behind the uterus, and in the oviduct. In most specimens the sperm are concentrated in the anterior part of the oviduct just behind the zone of eggshell formation, and for all practical purposes this region may be designated the seminal receptacle (Fig. 3D).

Zone of shell formation: Immediately posterior to the uterus there is a region in which very large, deeply basophilic, active-appearing cells continuous with the epithelium of the uterus, fill the entire lumen of the reproductive canal. These cells may be seen surrounding eggs within this region or closely applied to eggs which have just entered the uterus (Fig. 3E). The eggs pass either through the center of these large cells or to one side of them. Before the eggs enter this region from the oviduct they lack a shell; after they leave this zone and enter the uterus they have a completely-formed shell. Since Fauré-Fremiet (1912) and others have demonstrated that the chitinous shell of *Ascaris* eggs is formed from the glycogen of the egg, we make no attempt to interpret the large active cells of this region as shell-formers. Moreover, we have seen one abnormal egg in which part of the shell passes through the interior of the egg. Perhaps the large cells secrete an enzyme which activates the egg to synthesize its shell. There is good evidence that these cells form the thin outer coating of the egg described below.

Uterus: The uterus is a large tube formed of flat epithelial cells with bulging nuclei. It is not muscled except at the proximal end. The eggs in the uterus are finely vacuolate and have a thick laminated shell (11 μ). The shell is eosinophilic but a very thin basophilic membrane is closely applied to the outer surface of the egg, giving it a finely fibrillar appearance in cross section or slightly tubercled appearance in an end-on view. The egg shell of *T. figuratum* is relatively thinner and is unlaminated. The eggs have, however, a thick lightly basophilic inner membrane within the shell, corresponding to the vitelline membrane of such eggs as those of *Ascaris*. They are likewise insoluble in alcohol (cf. Timm, 1950), but fresh material will be necessary for further tests. Since this broad membrane is present even in eggs near the vulva it probably does not represent a stage in the transition of

glycogen to chitin. We propose the non-committal term "egg membrane" for this structure until it can be investigated more fully.

Near the vagina the uterus has a reduced sphincter with thick muscle cells on the ventral side. The most anterior portion of the uterus, as well as part of the vagina, are lined with the thick inner fiber layer which probably invaginates from the cuticle.

Numerous mitotic figures in late anaphase can be seen in the uterine eggs, some of them central and some of them peripheral. Probably cleavage begins before ovejection.

Vagina: The vagina is a short tube leading from the vulva to the uterus. It is lined with the same fibrous layer as that of the uterus, and with the long thin sclerotized pieces previously mentioned. Jägerskiöld described a vaginal sphincter and glands in *Cylicolaimus*. Türk described vaginal glands in *Thoracostoma strasseni*. We have not observed them in *T. figuratum*, *T. magnificum* or *Leptosomatum acephalatum*.

Vulva: The vulva is a slit-like opening to the exterior. It is lined with an invagination of all the layers of the external cuticle up to the sclerotized pieces of the vagina. In longitudinal section of two specimens there could be seen a large "plug" in the vulva which extends the full length of the vagina. The distal connection of the "plug" is uncertain, though it seems to be connected with the dorsal lining of the uteri (Fig. 3F). Possibly the "plug" functions as a valve, allowing only one uterus at a time to empty its eggs through the vulva and helping prevent the eggs from stradding the vaginal orifice.

Male.—The male reproductive system consists of paired testes, vas deferens, ejaculatory duct, cloaca and associated structures.

Testis: The anterior testis is located sublaterally at its distal end. It expands rapidly and becomes ventral, however, and is continuous with the vas deferens in the ventral line. Towards the proximal end of the anterior testis there is a thick epithelium with distinct cells and large elliptical nuclei. This epithelium spreads out very thinly over the distal end of the testis and nuclei cannot be seen. There is a thin but definite fibrillar layer surrounding the epithelium of the testis, probably derived from the somatic musculature.

The testis is divided into a germinal zone of short extent, a longer growth zone, a reduction zone, and a maturation zone. In the germinal zone there are large rounded nuclei embedded in cytoplasm; the cell boundaries cannot be seen. In the growth zone the cytoplasm shows definite cell outlines and the cells are arranged in orderly fashion around the border of the testis. In the reduction zone the cells are seen in various stages of cell division; some may have finished the first division while others at the same level are still undivided (Fig. 3A). Chromosome counts can be made most easily during the first mitotic division. The chromosome number seems to be twelve (2n). In the maturation zone the flagellate sperm are concentrated in large numbers, although there is no expanded portion corresponding to the seminal vesicle of some nematodes.

Vas deferens: The vas deferens is lined with low cuboidal cells in the

region between the anterior and posterior testes; there are 8-12 cells in cross section. The lumen narrows until only 6-10 sperm can pass through at the same time. As the posterior testis is approached the vas deferens widens. There is no duct but only a small orifice to the posterior testis; the epithelium of the vas deferens and posterior testis is continuous. The histology of the posterior testis is identical with that of the anterior testis but whereas the anterior is continuous in the ventral line with the vas deferens, the posterior is lateral in position throughout most of the length and only becomes sublateral at its distal end (Fig. 3A).

Ejaculatory duct: After its connection with the posterior testis the vas deferens thickens and the cells become low columnar in shape and vacuolate in appearance, with numerous secretory granules; this is apparently the only secretory portion of the male reproductive system. About midway between the end of the posterior testis and the anus, at the level of the first caudal gland, the ejaculatory duct begins. There is a layer of circular muscle cells with elongate nuclei surrounding the vas deferens (Fig. 3B). The cells of the vas deferens become indistinct in the region of the ejaculatory duct, possibly due to the pressure of the muscles. The ejaculatory duct unites with the intestine to form the common cloaca.

Spicules and gubernacula: The paired spicules consist of a head (capitulum) and a shaft (calomus); they are equal and similar. The paired gubernacula consist of a simple shaft or corpus. The spicules run together at the anus and pass through a ring or partial ring formed by the tips of the gubernacula. The spicules are enclosed within a definite spicular pouch (Fig. 3C). The spicular pouches fuse behind the cloaca, where the two spicules run closely parallel. There is a nucleus between the spicules in the spicular pouch tissue. Jägerskiöld reported a spicular pouch in *Thoracostoma* while Türk claimed that none was present; the pouch is frequently delicate in free-living nematodes.

NERVOUS SYSTEM

We will make no attempt to give anything more than elementary observations on the nervous system, since the finer structure of the nervous system is a study in itself.

At the extreme anterior are the amphids, sensory structures the exact function of which has not yet been determined. Two elongate sacs, the amphidial pouches, connect with the amphids and run posteriorly in the body cavity to the amphidial glands; they are basophilic and somewhat vacuolate. In a section through the amphids six papillary neurons can be seen, extending from the papillae and running posteriad parallel with the amphidial glands (Fig. 2B). The papillary neurons often seem to be divided into two, and toward the nerve ring they become irregular; their insertion in the nerve ring could not clearly be determined. All the nuclei of the neurons lie at about the same level behind the ocelli. A short distance behind these nuclei the glia cells can be seen on the outside of the neurons.

Türk pictures several cells in the body cavity of *Thoracostoma* next to the esophagus which he called esophageal mantle cells ("Schlundmantels Zellen"). These may be the same as the papillary neurons of *Leptosomatum*.

In *T. magnificum* there are large masses of spongy tissue running from the papillae and amphids; they follow posteriad along the esophagus as a loose vacuolate ring. Jägerskiöld gave nothing on the nervous system of *Cylicolaimus*.

There is a prominent fibrous nerve ring about one-third of the esophageal length from the anterior (Fig. 2C). A number of large ganglia are associated with the nerve ring.

There are prominent anal ganglia in *L. acephalatum*. Two large subdorsal and one smaller dorsal ganglion connect with the lateral chords in the region of the rectum just anterior to the anus (Fig. 3C). In addition to the anal ganglia in the male there are large ganglia behind the spicules which may be concerned with nervous control of copulatory activity.

SUMMARY

In this study the variety *Leptosomatum elongatum* Bastian, 1865, *acephalatum* Chitwood, 1936, has been elevated to the rank of a species. We have described and pictured the morphology completely for the first time for both male and female. Many observations on the histological anatomy seem to be reported here for the first time, some for the subfamily Leptosomatinae, others for the entire class Aphasmadia.

The new observations for the class Aphasmidia include:

Presence of a dorsal constrictor muscle of the vagina (p. 235).

Attachment of the retractor muscle of the spinneret (p. 236).

Absence of a naked (non-cuticularized) strip between the intestine and the rectum (p. 240).

Presence of a prominent inner "egg membrane" (p. 241).

Presence of large cells in what we have termed the zone of shell formation, possibly serving as activators of egg shell formation (p. 241).

Presence of a vulvar "plug" probably serving as a valve (p. 242).

New for the family Leptosomatinae and one of the few observations for the Aphasmidia is the description of the cuticular layering in *Leptosomatum* and *Thoracostoma* (p. 232). The presence of bacillary and subbacillary layers in the intestine of *Thoracostoma* (p. 239), and the determination of the chromosome number (p. 242) and the nuclei of the esophagointestinal valve (p. 239) in *Leptosomatum* are likewise unique for the subfamily.

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ABBREVIATIONS

amph—amphid
an—anus
ant—anterior
bac lay—bacillary layer
c—caudal
ceph—cephalic
ch—chord
c m—copulatory muscle
i obl cut—inner oblique layer of cuticle
int—intestine
i.v.—interno-ventral papilla
l—lateral
lev—levator
m—muscle
mat cut—matrix layer of cuticle
me—mesentery
m sh—muscular sheath
n—nucleus
n_{20}—nerve nucleus
nrv r—nerve ring
oc—ocellus
con—constrictor
d—dorsal
d.d.—dorso-dorsal papilla
dil—dilator
du—duct
eg—fertilized egg
ej—ejaculatory
e.l.—externo-lateral papilla
o c—"oval cell"
o cut—outer layer of cuticle
or—orifice
ov—ovary
pap neu—papillary neuron
pl—"plug"
post—posterior
pou—spicular pouch
ppl—papilla
pr spc—primary spermatocyte
r—rectum
rad—radial
rfl—reflex
s—sphincter
scl p—sclerotized piece
es—esophagus
g_1—dorsal gland nucleus
gl—gland
gn—ganglion
gr z—growth zone
gub—gubernaculum
i.d.—interno-dorsal papilla
i.l.—interno-lateral papilla
sem r—seminal receptacle
som—somatic
sp—spicule
spn—spinneret
sv—subventral
t—testis
ut—uterus
v—ventral
$v_{6,7}$—nuclei of esophageal valve sphincter
va—vagina
v d—vas deferens
vul—vulva
v.v.—ventro-ventral papilla
z s form—zone of shell formation

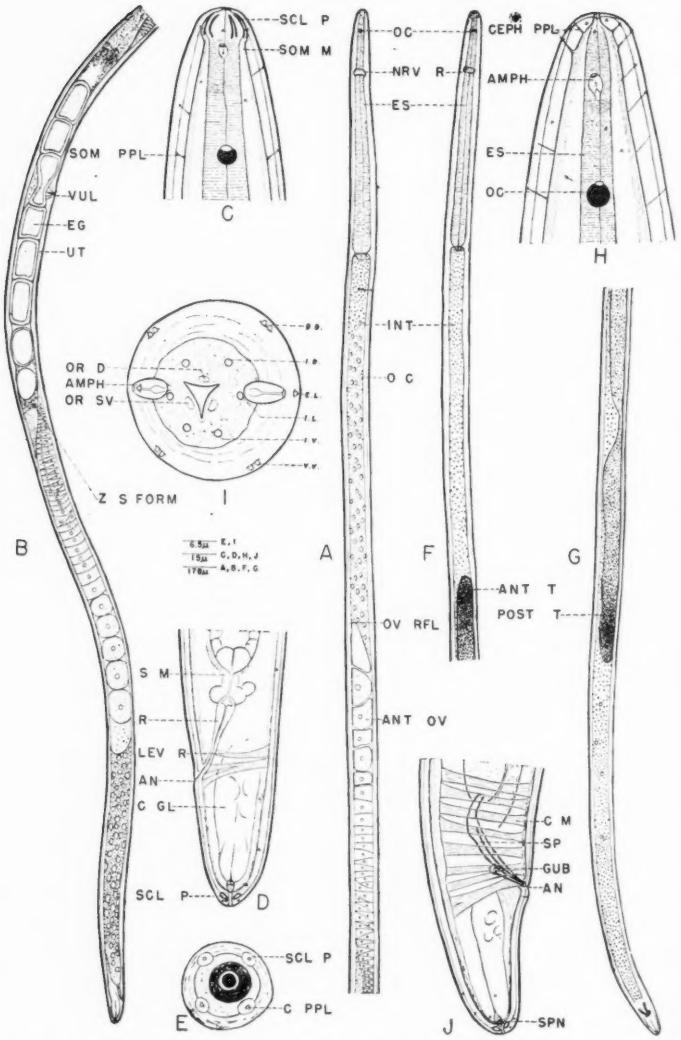

Fig. 1.—*Leptosomatum acephalatum*. A, B. Dorso-lateral view of adult female. C. Lateral view of female head. D. Lateral view of female tail. E. *En taille* cross-section of female tail. F, G. Lateral view of adult male. H. Lateral view of male head. I. *En face* view of male head. J. Lateral view of male tail.

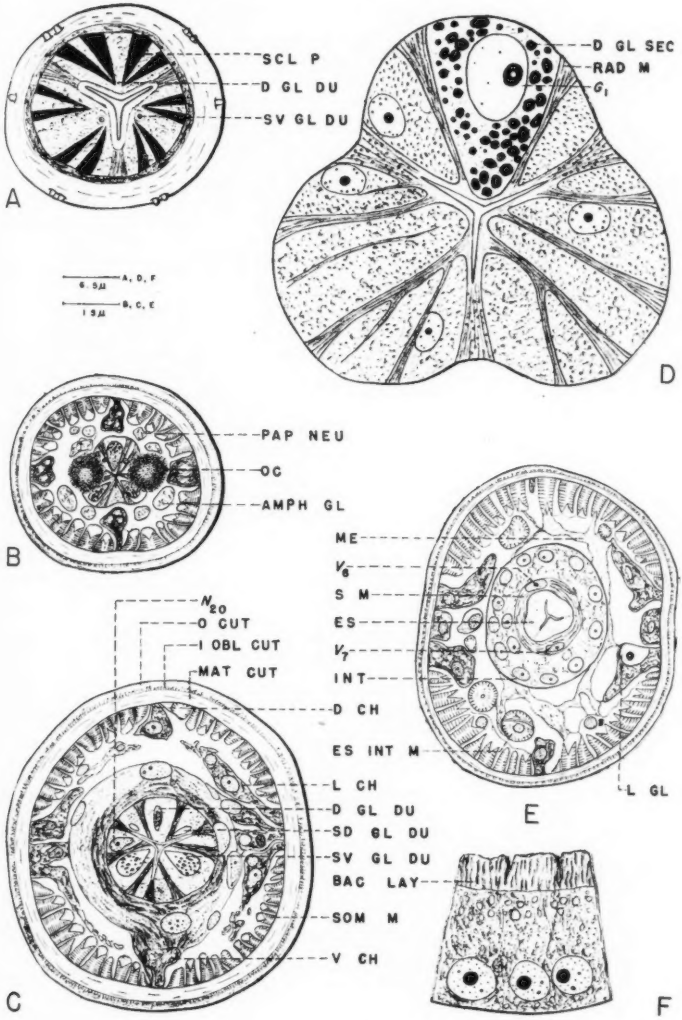

Fig. 2.—*Leptosomatum acephalatum.* A. Cross-section through esophageal "cap" of female. B. Cross-section through ocelli. C. Cross-section through nerve ring. D. Cross-section through glandular region of esophagus. E. Cross-section through esophago-intestinal valve. F. Highly magnified portion of intestine just behind the esophago-intestinal valve.

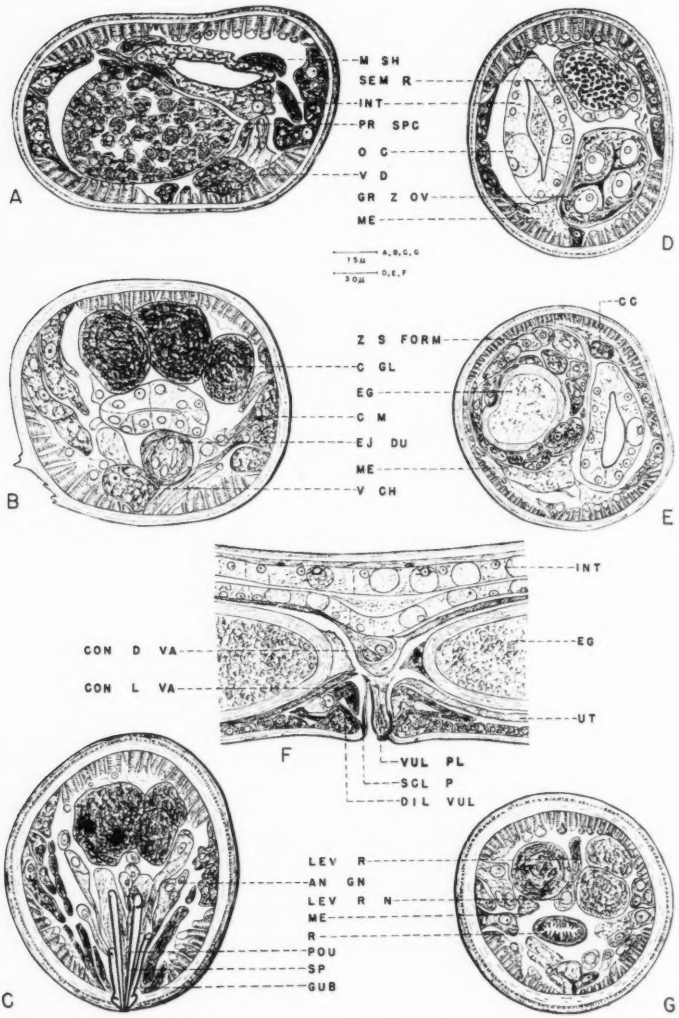

Fig. 3.—*Leptosomatum acephalatum*. A. Cross-section through posterior testis. B. Cross-section through caudal glands and ejaculatory duct. C. Cross-section through spicules and gubernacula. D. Cross-section through posterior ovary and seminal receptacle. E. Cross-section through anterior zone of shell formation. F. Longitudinal section through vulva. G. Cross-section through rectum of female.

New Host Records for Mesocestoides (Cestoda: Cyclophyllidea) in California

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Webster (1949) reported the occurrence of tetrathyridia in *Peromyscus boylii boylii* from California and he also described *Mesocestoides* larvae found in a lizard in Texas.

Several more host records for larval and adult *Mesocestoides* will be reported here and descriptions given of the larvae. I am grateful to Dr. Wade Fox, Department of Zoology, University of Southern California, Los Angeles, for collecting the specimens from the garter snake *Thamnophis elegans* and from the Pacific fence lizard *Sceloporus occidentalis;* and to Dr. Alden H. Miller, Museum of Vertebrate Zoology, University of California, Berkeley, for the specimens from the foxes *Vulpes macrotis* and *Urocyon littoralis.*

Records and Description

Tetrathyridia were found in the following species of lizards: *Gerrhonotus coeruleus* collected May 11, 1951, in Tilden Park, Contra Costa Co., California, supplied eighteen specimens for study. Total length of the larvae ranged from 1-2.1 mm; scolex diameter from 178-234 μ; sucker diameter from 42-82 μ. In all of the larvae, two pairs of excretory ducts and a posterior excretory vesicle were observed. In one specimen cross-connections between the median excretory ducts were seen (Fig. 1). Numerous fine strands of tissue (probably muscular) led from the scolex to the posterior end of the larva. Scolices and suckers were well developed in all specimens.

One *Sceloporus occidentalis* collected October 16, 1944, in Strawberry Canyon, Alameda Co., California, contained over 25 tetrathyridia. Total length (measured in specimens with inverted scolices only) ranged from 1.7-4.5 mm; scolex diameter from 192-311 μ; sucker diameter from 53-85 μ. Two pairs of excretory ducts and an excretory vesicle were visible in some specimens.

Numerous specimens of tetrathyridia from *Eumeces fasciatus* in California were found in the study collection of the Department of Zoology, University of California, Berkeley. Information on the exact date and place of collection was not available. Most of these larvae were immature, as indicated by a feebly developed sucker musculature and by indistinct outlines of the scolex. A double inversion of the scolex was observed in a few specimens. Total length ranged from 0.5-1 mm; scolex diameter from 182-340 μ; sucker diameter from 65-85 μ. The lateral pair of excretory ducts was difficult to see in most specimens.

The snake hosts for tetrathyridia were as follows: *Thamnophis elegans*

collected May 8, 1946, on Dillon Beach, Marin Co., California. Ten larvae were available for study. Their total length ranged from 1.3-1.7 mm; scolex diameter from 204-259 μ; sucker diameter from 71-85 μ. The excretory system was as described above.

One *Crotalus viridis* which had died in captivity, was examined August 20, 1951. Exact locality of capture could not be ascertained, but it is likely that the snake was collected in the northern part of California. Over 30 tetrathyridia were found in the intestinal mesenteries. Most of the specimens

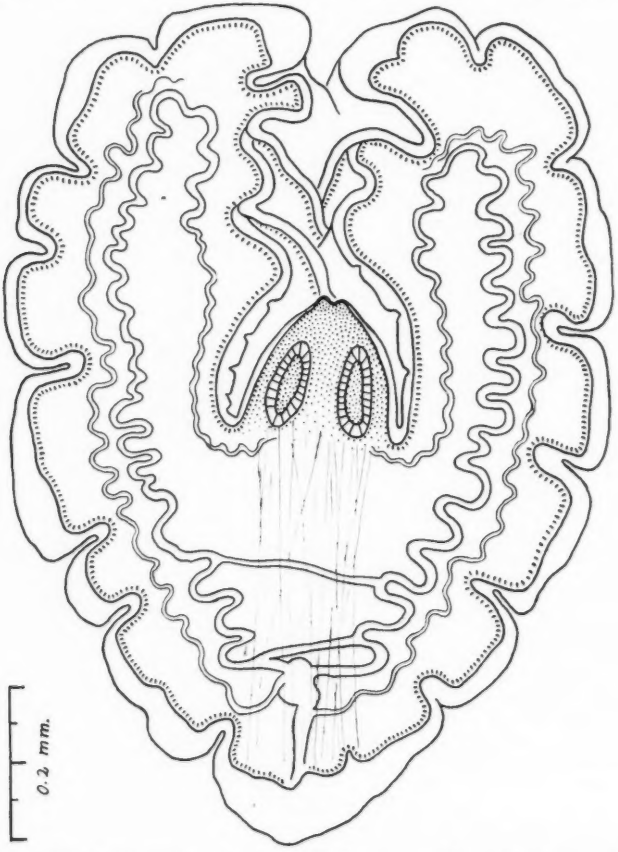

Fig. 1.—Tetrathyridium from the lizard *Gerrhonotus coeruleus*, showing two pairs of excretory ducts with cross-connections, an excretory vesicle, and muscle fibers leading from the scolex to the posterior end of the larva.

were immature, measuring 0.8 mm in length. Scolex diameter ranged from 144-180 μ; sucker diameter from 49-81 μ. Only one pair of excretory ducts could be seen.

Similarity in size of scolices and suckers of all above described specimens suggests that they all belong to the same species of *Mesocestoides*. It is likely that they are larvae of *Mesocestoides variabilis* Mueller.

Adult *Mesocestoides variabilis* were found in the small intestine of the kitfox *Vulpes macrotis* caught April 5, 1951, in the Pinto Basin, Riverside Co., California; also in *Canis latrans* and *Lynx rufus*, both from the Hastings Reservation, Monterey Co., California, examined June 14 and December 6, 1945; also in *Didelphis virginiana* caught March 3, 1951, in Tilden Park, Contra Costa Co., California. A species of *Mesocestoides* resembling *Mesocestoides manteri* Chandler, was obtained from *Urocyon littoralis* caught March 10, 1950, on Santa Rosa Island, Santa Barbara Co., California.

Additional records of distribution of *M. variabilis* within the state were obtained as follows: from *Urocyon cinereoargenteus* and *Mephitis mephitis* from the Hastings Reservation, Monterey Co., California; from *Urocyon cinereoargenteus* at Grey Lodge Refuge, Butte Co., California.

SUMMARY

Mesocestoides larvae are reported from the lizards *Gerrhonotus coeruleus*, *Sceloporus occidentalis* and *Eumeces fasicatus;* and from the snakes *Thamnophis elegans* and *Crotalus viridis*. Adult *Mesocestoides variabilis* are recorded from the carnivores *Vulpes macrotis*, *Canis latrans* and *Lynx rufus;* also from the opossum *Didelphis virginiana*. *Mesocestoides* sp. was found in the small intestine of the fox *Urocyon littoralis*. All hosts listed above were caught in California. Descriptions of the tetrathyridia are included.

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Notes on the Vertical Distribution of Organisms in the Profundal Sediments of Douglas Lake, Michigan[1,2]

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Benthic populations of inland lakes are commonly discussed in terms of organisms per square meter of bottom surface, often with reference to changes occurring during some period of time. However, the vertical distribution of animals within the sediments has been neglected to a great extent in North America. Lenz (1931) and Berg (1938) have contributed to our knowledge of this aspect of faunal distribution in European lakes. Moore (1939) and Cole (1949) have reported on the vertical distribution of the microbenthos in bottom deposits of certain lakes of this continent, but little information has been published concerning the stratification of macrobenthic forms, particularly the profundal organisms.

Apparatus and Methods

Thirty benthic collections, each composed of three vertical core samples, were taken from profundal depths in Douglas Lake, Cheboygan County, Michigan, from August 4 to August 26, 1950. Eight collections were made in the upper profundal zone at a water depth of 16 meters, and twenty-two collections were taken from a depth of 19.5 meters. Both stations were in the South Fish Tail Bay depression along a transect extending lakeward from a permanent marker on the west shore. In addition to the 90 profundal core samples, 8 cores were taken at sublittoral and littoral depths for comparative purposes.

All benthic collections were made with a small vertical core sampler, described in another paper (Cole, 1949). An inserted transparent plastic tube served to collect the core of sediment and its biota. This tube was removed from the sampler, transported to the laboratory in a wooden rack, and the included mud was removed in sections for examination. The sectioning was accomplished, after the water overlying the core had been siphoned off, by pushing a rubber piston up the tube from the bottom. A rod, calibrated in centimeters, was used to push the piston, and hence the mud core, up through and above the upper edge of the tube. A tight-fitting, waterproof bowl encircled the tube, and served to catch watery sediment which spilled over the top. An ordinary glass slide was used to scrape the mud from the top of the tube, and a rubber syringe was employed in washing the outside of the tube and in removing the sediment from the bowl. The three cores, comprising one collection, were sectioned in succession and their corresponding strata consolidated in finger bowls. The upper 10 cm. of each core was sectioned at one cm. intervals and screened with a metal sieve of 80 meshes to the inch. The second 10 cm. was sectioned at 2 cm. intervals and screened

1 This investigation was made possible by a grant from the Research Fund, University of Louisville.

2 Contribution from the Biological Station, University of Michigan.

with a 65 mesh Tyler sieve. Strata below 20 cm. were divided at 4 cm. intervals and screened with the 65 mesh sieve. After screening, each stratum was placed in the proper finger bowl and examined with the aid of a binocular microscope (magnification 10.5x).

Although a few cores included as many as 30 cm. of sediment, the data apply only to a depth of 24 cm., each core with a surface area of 3.8 square centimeters.

Obviously the method of collecting and sectioning cores did not yield information other than a record of how benthic organisms were distributed at the time the cores were sectioned. Vertical displacement of the more motile species could not be determined. However, limiting the collections to three cores each, and proceeding with the sectioning immediately after collecting allowed little time for wandering. This source of error might have been almost completely eliminated by utilizing a "stratification bottom sampler" similar to those used by Lenz (1931) and Berg (1938).

SAMPLING STATIONS

Physico-chemical factors.—Table 1 shows results of physico-chemical determinations made August 12, 1950 in the South Fish Tail Bay depression. Throughout the course of this study these factors varied little. Both stations were in the profundal zone according to the limits defined for Douglas Lake by Eggleton (1931). The 16 m. station was near the lower limit of the thermocline, while the 19.5 m. was well within the hypolimnion.

TABLE 1.—Physico-chemical factors of profundal waters

Water Depth	C°	O_2	CO_2	pH	Total Alkalinity	Conductivity
16 m.	8.4	0.01 p.p.m.	15.4 p.p.m.	7.0	125 p.p.m.	225 mho
20 m.	6.8	none	16.5 p.p.m.	6.9	135 p.p.m.	240 mho

Sediments.—There appeared to be no difference in the sediments at 16 m. and at 19.5 m. The upper 15 cm. was blackened and composed of fine material. Below this there was a trend to brown color which became well marked at about 20 cm. Here the bottom deposits were more compacted and decidedly gelatinous. The upper strata were watery, spilling over the top of the plastic tube when raised a centimeter above it during the sectioning procedure. When the 7-8 cm. stratum was reached the material was usually solid enough to hold its shape when pushed above the end of the tube. Moore (1939) has described these sediments in greater detail.

MICROBENTHOS

Many of the microscopic bottom forms were retained in the fine-meshed screens, and were recorded when observed. Microbenthic populations at the two stations differed more than did the macroscopic portions of the benthos. At 16 m. *Canthocamptus staphylinoides* Pearse was common, but only one individual was seen in the 19.5 m. collections. Active and encysted individuals occurred from the surface to at least 14 cm. in the ooze. Cysts were present in the upper two centimeters as well as the underlying strata, and

active individuals were found as far down as the 14-16 cm. level. At both depths encysted and a few active *Cyclops bicuspidatus thomasi* Forbes in the 4th copepodid stage were abundant, but the greatest numbers were found in the deeper waters. Their cysts were found as far down as the 16-18 cm. level. Nematode worms, large enough to be retained by the screens, were found only at 16 meters, where they occurred in small numbers down to the 8-9 cm. stratum. Of the ostracods, *Candona simpsoni* Sharpe occurred in five of the 16 m. collections, but was not found at the deep station; *Physocypria pustulosa* (Sharpe) was observed in one sample from 16 m., and *Cypria turneri* Hoff was noted from both depths several times.

Unusual records included *Ilyocryptus sordidus* (Liéven) 8 cm. down in the ooze at 16 m., and two occurrences (probably accidental) of *Mesocyclops edax* (Forbes) at 19.5 meters.

Thus, four microbenthic forms, only two of which were common, occurred at the deeper station, while seven species, of which five were abundant, were recorded from the shallow station.

MACROBENTHOS

The macrobenthic animals sampled in the profundal collections were dominated by tubificid oligochaetes of the genus *Limnodrilus*. Eggleton (1931) recorded *L. hoffmeisteri* Claparède and *L. claparèdianus* Ratzel from profundal sediments of Douglas Lake. No attempt was made to identify them specifically during the course of the present investigation.

Tendipes plumosus (L.) was the next most abundant animal, although only 10 were collected in the cores. Twelve other dipterous larvae, including 8 larval *Chaoborus punctipennis* (Say), were also taken. The only other macrobenthic forms were one individual of the molluscan genus, *Sphaerium*, and an unidentified oligochaete. Altogether, 106 macrobenthic individuals were collected in the 90 profundal cores (Table 2).

Oligochaeta.—Limnodrilus was more abundant in the 16 m. collections than in those from 19.5 m. Of the total number, more than ninety-one percent occurred in the upper 14 cm. of sediment. Only seven individuals were found below this stratum.

An interesting feature of the tubificid stratification was the comparative scarcity of animals (7.4% of the total) at the surface and in the upper centimeter of sediment when compared to numbers below this level. At 19.5 m. there was a conspicuous grouping of worms in the 2-3 cm. stratum. This was not so marked at 16 m., although it was clear that relatively few were in the uppermost stratum.

The paucity of worms in the uppermost layer differs from what was found concerning littoral and sublittoral oligochaete populations in Crystal Lake, Minnesota (cf. Cole, 1949). Using the same sampling gear and sectioning technique, it was found that 60% of all oligochaete worms (mostly naidids) were at the surface or in the upper centimeter of soft deposits. Oligochaetes did not occur in the profundal zone of Crystal Lake, so no exact comparison can be made. However, a Douglas Lake sublittoral collection (11.5 m.) comprised of three cores made during August, 1950, contained six worms of the genus *Limnodrilus*, including two in the uppermost stratum. Of the thirty profundal collections, only one had as many as two tubificids in the

top centimeter. A core from the littoral zone (4 m.) of Douglas Lake contained three naidids, of which two were in the top layer. These data are too few to warrant more than speculation as to whether there is a significant difference between vertical penetration of *Limnodrilus* at different benthic regions, or between the stratification of the naidids and tubificids.

TABLE 2.—Vertical distribution of macrobenthos in profundal sediments of Douglas Lake during August 1950

Depth in Cm.	16 Meters (24 cores)					19.5 Meters (66 cores)					
	L	T	Ta	Cha	S	L	T	Ta	Cha	O	Total
0–1	2	–	–	1	–	4	1	–	3	1	12
1–2	6	–	2	–	–	16	1	–	1	–	26
2–3	7	–	–	–	–	3	2	–	–	–	12
3–4	4	1	1	–	1	3	1	–	1	–	12
4–5	–	1	–	–	–	6	1	–	–	–	8
5–6	–	–	–	–	–	3	1	–	–	–	4
6–7	1	–	–	–	–	5	–	1	1	–	8
7–8	3	–	–	–	–	5	–	–	–	–	8
8–9	1	–	–	–	–	–	–	–	–	–	1
9–10	–	–	–	–	–	1	–	–	1	–	2
10–12	1	1	–	–	–	1	–	–	–	–	3
12–14	3	–	–	–	–	–	–	–	–	–	3
14–16	–	–	–	–	–	5	–	–	–	–	5
16–18	–	–	–	–	–	1	–	–	–	–	1
18–20	–	–	–	–	–	–	–	–	–	–	0
20–24	–	–	–	–	–	1	–	–	–	–	1
Totals	28	3	3	1	1	54	7	1	7	1	106

Key: L—*Limnodrilus* spp., T—*Tendipes plumosus*, Ta—*Tanypodinae*, Cha—*Chaoborus punctipennis*, S—*Sphaerium* sp., O—Unidentified oligochaete.

Dipterous larvae.—No significant difference could be detected between *Tendipes plumosus* populations at the two stations. Only one larva was found in the uppermost centimeter, most of the individuals being present between two and six centimeters below the ooze surface.

Four larvae of the subfamily Tanypodinae were found, but only one of these was collected at 19.5 m. Of the eight *Chaoborus punctipennis* larvae found, seven were at the 19.5 m. station where almost three times as many cores were taken. Four larvae were in the upper stratum, the rest scattered down to the 9-10 cm. layer. With so few animals represented it was not possible to find evidence of migration by comparing morning and afternoon samples.

As with the annelid worms, there are differences between the Douglas Lake data and those from Crystal Lake, Minnesota (Cole, 1949). Thirty-two cores taken throughout the seasons of the year on soft bottom in Crystal Lake contained dipterous larvae. All of these were tendipedids except for a ceratopogonid found in the 15-20 cm. layer, and three individuals of *Chaoborus*, one each in the 0-1, 5-6, and 8-10 cm. strata. Out of a total of 46 animals, 69.57% were on the surface and in the first centimeter of deposits, and all but 10.87% of the total counted were in the upper four centimeters.

On firm sand bottoms the larvae were not found below the second centimeter. Most of the Crystal Lake data apply to littoral and sublittoral bottoms. *Tendipes plumosus* did not occur in this body of water, and profundal tendipedids were collected only during the fall overturn, being absent or extremely scarce at other seasons.

Mollusca.—On one occasion a young *Sphaerium* was found in the 3-4 cm. stratum at 16 meters.

CONCLUSIONS AND DISCUSSION

The over-all picture of the vertical distribution of profundal macrobenthos in Douglas Lake during late summer indicates 93.4% of the total population to be between the surface and 14 cm. in the sediment. Berg (1938) stated that upwards of 90% of the macroscopic bottom fauna were between 0-15 cm. in the several Danish lakes he investigated. In Esrom Lake he found a considerable number of animals to occur down to a depth of about 30 cm. and possibly a few still deeper. Perhaps the deepest occurrence in Douglas Lake (one *Limnodrilus* in the 20-24 cm. stratum) is not indicative of the penetration to be expected at other seasons, or with a greater number of samples, for that matter. Berg (1938) found the spring population maximum to be between 5 and 10 cm., while the summer and autumn maxima were from zero to 5 cm. These facts indicate seasonal vertical shifts in populations might also be expected in Douglas Lake.

SUMMARY

Ninety vertical core samples were taken from the profundal sediments of Douglas Lake, Michigan, during August, 1950. Cores were sectioned at intervals and the animals present in each stratum were recorded.

Eight microbenthic forms were identified, more species occurring in upper profundal depths than in deeper regions. Encysted *Cyclops bicuspidatus thomasi* penetrated deeper in the sediments than other microscopic species, being present more than 16 cm. below the ooze surface.

One hundred and six macrobenthic organisms, representing at least five species, were present in the samples. Ninety-three percent of these were found in the upper 14 cm. of the bottom deposits, with the 1-2 cm. level containing more individuals than any other single stratum. The deepest penetration (*Limnodrilus* sp.) was the 20-24 cm. stratum.

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